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The CORNELL ENGINEER

Volume 11 Number 3

CONTENTS

Effort, Fatigue and the Engineer 7
Dr. T. A. Ryan

X-Ray Applications in Industry 10
Kenneth M. Gellhaus, EE '48

Engineering at Cornell—10 12
Billie P. Carter, ChemE '49

Profiles 13

Prominent Engineers 14

Techni-Briefs 16

News of the College 17

Alumni News 18

President's Message 20

Stress and Strain 40

Cover: A view of the proposed new Civil Engineering Building

Frontis: A sorting machine-mass spectograph

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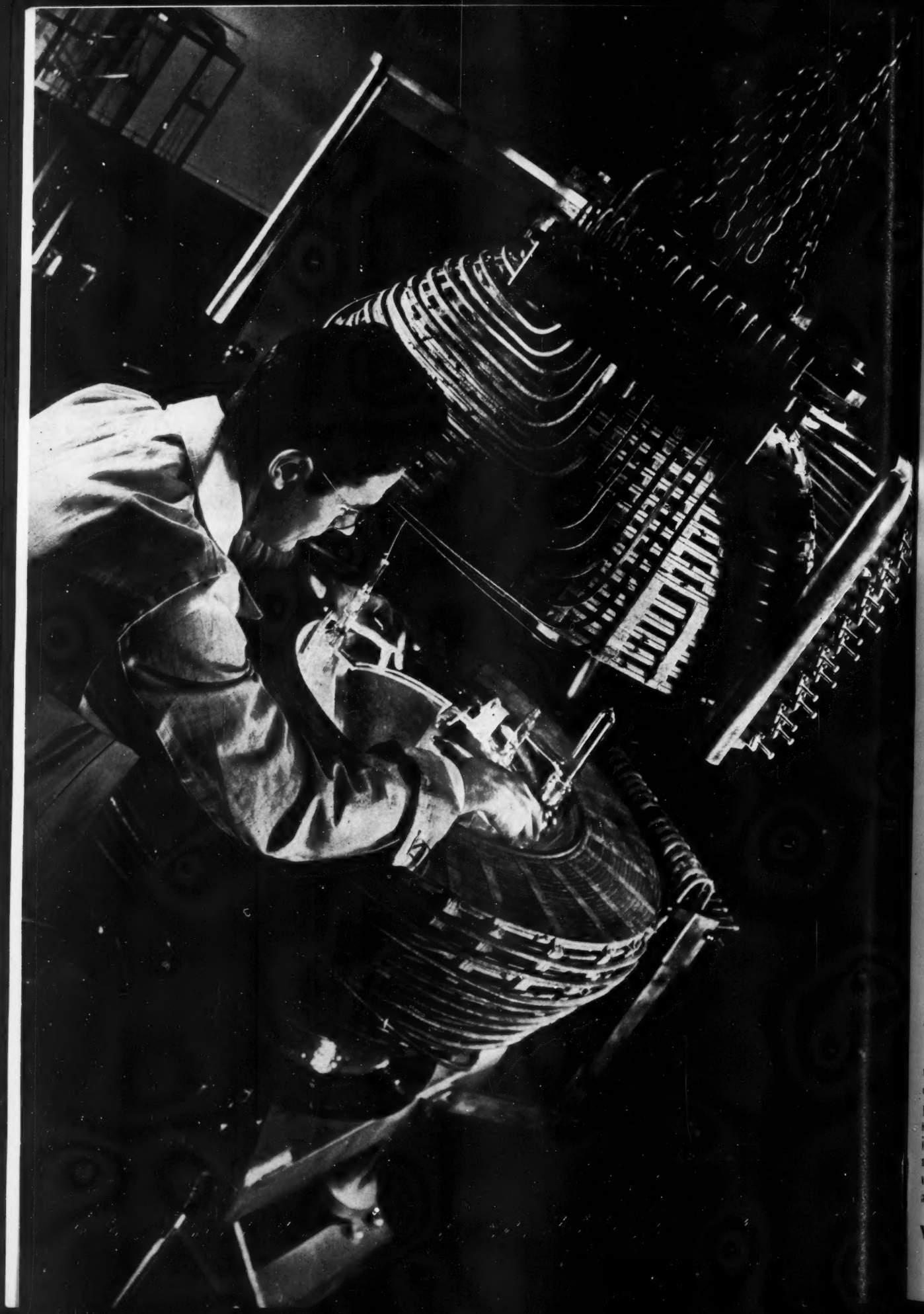

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EFFORT, FATIGUE AND THE ENGINEER

By DR. T. A. RYAN

THE association of terms in our title may be taken by the student engineer to refer to his own personal concern with the amount of effort he is expected to devote to his studies, and the fatigue which he experiences following "Mech. Lab." reports. While he may be justified in making that interpretation, the present article is concerned with the professional interests of the engineer in human effort and fatigue as scientific problems, rather than his personal interest in his own exertions and weariness.

Effort and fatigue involve a large number of difficult scientific problems which are likely to be met in many different phases of engineering work. When those problems arise, the engineer is likely to turn to physiologists and psychologists for aid, but he will derive more benefit from his search if he has a general understanding of the present status of this field of research activity. This discussion will have two aims: first, to give some conception of the importance of scientific studies of effort and fatigue to the engineer by citing specific examples of problems which are now sources of difficulty in industry or elsewhere; and second, to sketch very briefly what is being done to answer some of these troublesome questions.

Time Study

The most obvious instances of the need for more knowledge of effort arise in industrial production, particularly in relation to time-study. A standard time for each job is needed for establishing fair piece-rate or bonus payments, for scheduling work, estimating labor costs, and the like. The standard time which is desired for each task is the time required for a man of standard skill, *working with average effort,* to do the job. Therefore, until we have some method of *measuring* effort, establishing accurate standard times is an impossibility. At present, time-study men resort to a process of estimation, the accuracy of which is largely unknown. Meanwhile, time-standards represent a source of considerable friction and irritation on the part of the worker, and they may be a real source of loss of output.

Before going on to other examples of the problem, we may profitably consider what is meant by 'measuring effort.' If the human organism were a motor, we could apply to it the same tests which the engineer would use, that is, we could measure the energy requirements of the body during work. In that case, standard time would always refer to work accomplished with a standard rate of energy expenditure per hour. Unfortunately, however, energy requirements do not furnish us with a satisfactory index of effort in most jobs. As an extreme case in point, a man who does difficult calculations "in his head" may be extremely weary at the end of a few hours of work. Yet, his energy requirement in terms of calories for this work is not as much as the energy required to sit up for the equivalent period of time. If energy were our measure of effort, then, we should be faced with the paradox that a man doing difficult mental work does not expend as much effort in a day as a man in heavy labor expends in a few minutes. We can only conclude that energy measure-

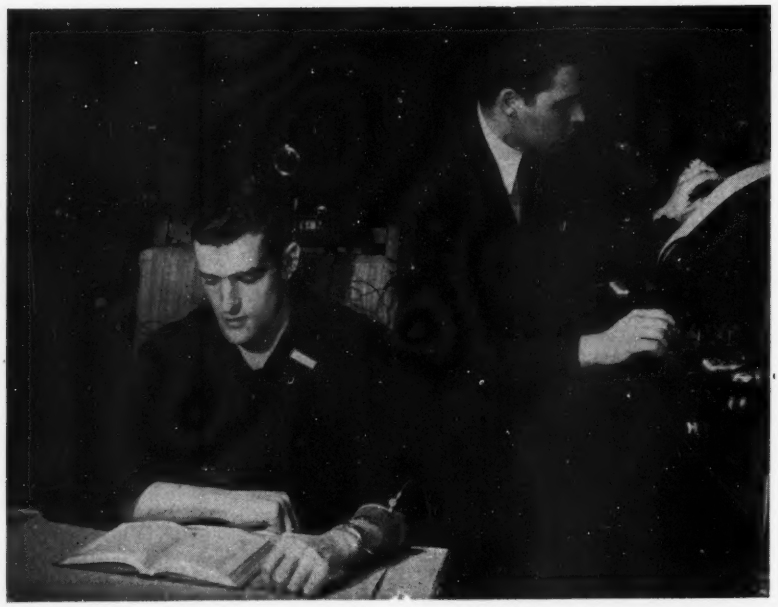
THE AUTHOR

In 1933, Dr. T. A. Ryan graduated from Cornell, having studied here as a major in psychology. He studied under a Sage Scholarship in Psychology during 1933-1934 and then in 1937 he was awarded his Ph.D. by the University.

Dr. Ryan has written papers and has done research in the fields of thinking, perception, learning, interest testing, and personnel. He is now completing a book on human efficiency tentatively entitled "Work and Effort—The Psychology of Efficiency."

Now teaching courses in applied psychology, the doctor has formerly taught Personnel Management and Statistics and during the war taught mathematics and also held classes in the ASTP Personnel Program at Cornell.

Dr. Ryan



The claim that eyestrain affects the frequency of blinking and heart-rate was tested in the Cornell Laboratory of Psychology by means of the apparatus shown above. Electrical potentials from the eyelid and the heart picked up by electrodes, amplified and recorded graphically.

ments furnish a useful index of effort only when the work is physical—where the output can be efficiently expressed in terms of foot-pounds. It is evident that most jobs involve an element of skill which makes an expression of output in physical terms a meaningless procedure.

Factors of Efficiency

Much of the work of scientists studying the problem of effort in recent years has been devoted to a search for other indicators which would reflect the broader aspects of cost of work to the organism. By electrical measurements on the body it has been shown that muscular tensions are correlated with mental effort as well as physical labor. The heart and circulation undergo changes during work of any kind. The individual's ability to perform on various tests such as tests of speed of reaction and co-ordination, changes with the time spent at work. All such changes are highly irregular, however, and are affected by many other factors outside of the effort required by the work itself. Many of the measurements can be made only under laboratory conditions.

For all of these reasons, therefore, we must conclude that the measurement of effort is still in the exploratory stage and we are not ready to offer any solution to the problem of time-standards which would eliminate the judgment of time-study men. Meanwhile, those engineers who are concerned with industrial production have a real stake in seeing that research into this problem is prosecuted with zeal and with the support of industry. Progress in research of this kind would mean eliminating a serious source of difficulty in industrial relations. This is not to say that present methods should not be used—they are all that are available—but the engineer should be interested in seeing that improvements are made.

Another phase of production management, methods engineering, is also intimately concerned with the measurement of effort. Methods engineers have made great progress in designing methods of work which eliminate waste—waste of time, materials, money, and effort. They aim to increase the productivity of the worker without increasing the cost of work to the worker—his output. In many instances the reduction in wasted effort is so obvious that no accurate measurement is necessary. The fact remains, however, that methods of work are evaluated in terms of production rate alone, and that the methods engineer has no way of evaluating effort except in terms of his judgment. In some instances his judgment has been questioned by the workers, who contend that their effort has been increased along with their productivity. Such arguments, like those concerning time standards, cannot be settled conclusively without adequate objective measures of the effort involved in the work.

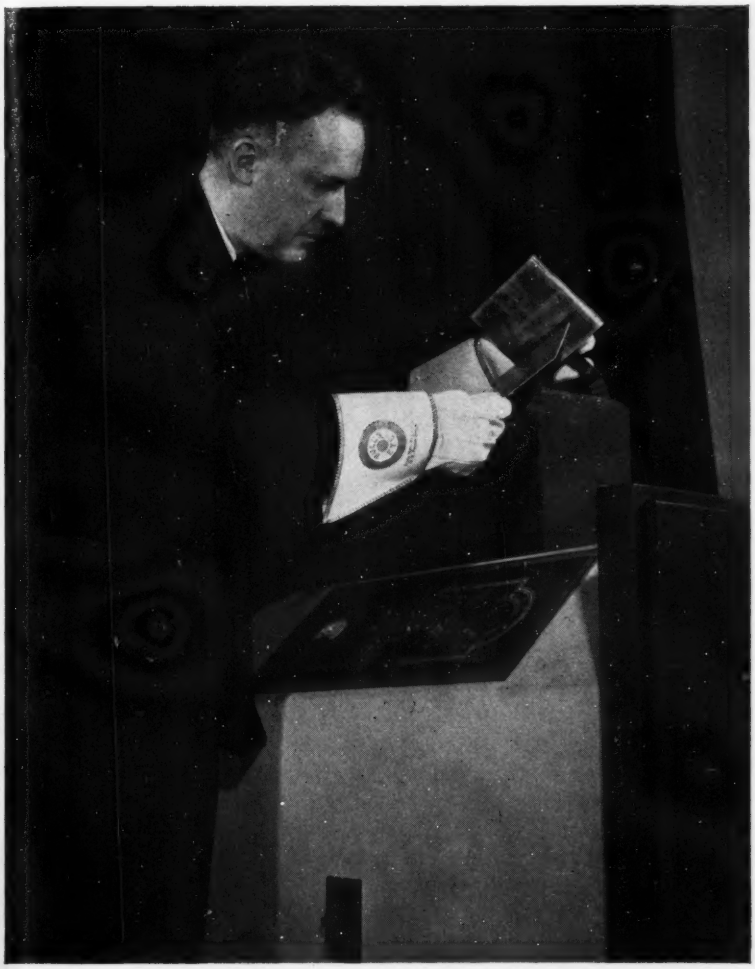
Illuminating Engineering

As another example of the engineer's interest in effort and fatigue we may turn to an entirely different branch of the profession—illuminating engineering. In designing equipment for lighting the school, office, factory, or home, the engineer aims to provide economy in the use of electrical power, pleasing artistic effects, and, most of all, conditions which will permit a maximum of visual work with a minimum of visual fatigue. In the last analysis, then, the test of good lighting equipment depends upon our ability to measure accurately the visual "wear and tear" or eyestrain which results from working in rooms illuminated by that equipment.

If we could afford to spend five or ten years in testing each new design, we might find that the effects of a given lighting system would result in deteriorations of eyesight which would show up in the ordinary oculist's examinations. Obviously, however, we cannot afford experiments which expend so much time and run so much risk of damage to the subjects. On the other hand, tests of job performance under given lighting conditions are too insensitive. We can work almost as fast under very poor lighting conditions as we can under good ones, although we probably draw upon our reserves too heavily in doing so. Visual specialists are searching, therefore, for some index which will show the amount of loss to the visual mechanism itself during a single day or a few days of work, and thus reveal how heavily we have drawn upon our reserves in working under any given conditions.

At present there is considerable controversy over the question of the amounts of illumination which are beneficial for reading or other close

work. Using certain proposed tests of visual fatigue, some influential researchers have contended that we can benefit by raising the lighting level up as high as 100 foot-candles for ordinary reading, providing that we avoid glare in doing so. Yet speed of reading ordinary books or the performance of many other visual tasks does not improve with additional light once we pass a level of 10-20 foot-candles. The recommendations of higher illumination are based upon the belief that we are less fatigued under high illumination even though we do not work any faster.



Engineer making motion and fatigue study in industry.

Two of the measures of visual fatigue which are the basis of these recommendations for high levels of illumination have recently been tested in the Cornell Department of Psychology. Dr. M. E. Bitterman, who carried on this research, failed to find any evidence that these measures are measures of visual "fatigue."[1] In fact, some of the results were the reverse of those which had been claimed, even though all of the results are based upon electrical recordings taken in an air-conditioned room in order to eliminate the influence of temperature upon the physiological changes in the subjects.

Visual Fatigue

In view of the conflicting results now available on various proposed measures of visual fatigue, we must view with caution the claims which are made for the benefits to be gained by the use of various proposed lighting systems. The lighting engineer must now work largely by judgment and rule of thumb insofar as his evaluations of the visual effects of lighting are concerned. In discussions with members of the Cornell Engineering Faculty who are interested in illumination problems, I have found that they are fully aware of this situation, and are intensely interested in seeing further progress in physiological and psychological research related to their field.

As a final example, we may consider the program of research which is planned by the College of Engineering upon the subject of radiant methods of heating and cooling. As stated in the first report on the project, "The purpose of the broad study is to investigate the various physiological, psychological, and engineering factors that are related to the comfort and economy of radiant heating and cooling."[2] This program is to be planned by a committee consisting of engineers, physicians, physiologists, and psychologists, and represents the type of approach which is coming to be more and more frequently applied to engineering problems. This close cooperation of various specialists is important in all of the problems which have provided examples in this article. The physiological and psychological side of the problem is, as the above statement would indicate, broader than the topic of the present discussion, since it is concerned with the whole effect of the heating or cooling system upon the occupants of a room. Nevertheless, effort and fatigue will be important aspects to be considered, and we may indicate the nature of the relationship here.

Temperature Effects

If we are interested in finding the effects of temperature upon subjects engaged in sedentary occupations, we must face a discouraging fact which previous investigators have found. In those experiments, the ability of the subject to perform his task was not affected *at all* by wide variations in temperature and humidity under test conditions. Yet there is a common belief that

(*Continued on page* 38)

1 M. E. Bitterman, Heart rate and frequency of blinking as indices of visual efficiency, *Journal of Experimental Psychology*, 35, 1945, 279-292.

2 C. O. Mackey, L. T. Wright, Jr., R. E. Clark, and N. R. Gay, Radiant Heating and Cooling, Part I., *Cornell University Engineering Experiment Station*, Bulletin No. 32, 1943, p. 3.

X-RAY APPLICATIONS IN INDUSTRY

By KENNETH M. GELLHAUS, EE '48

ESSENTIAL, widespread demands on X-rays and the latest associated techniques were ushered in with the Second World War. The urgent demand for special castings involving difficult foundry practice immediately resulted in extensive use of X-rays in the development stage of casting production. Many foundries installed X-rays for this purpose, but the most striking development in this line was to be found in the light-alloy industry. These firms were quick to take advantage of this method of investigation, which was particularly valuable because light alloys are very transparent to X-rays and afford ideal material for X-ray inspection.

Britain as well as the United States found X-rays almost indispensable in quantity war production. In each new pattern of casting, when the foundry development period ended and production began, a fixed number of the first patterns produced were critically examined by X-rays in accordance with an official technique. If this number were found to be free from defects, the inspector reduced the bulk X-ray inspection of succeeding castings to any percentage he thought fit after consideration of all the relevant factors.

Percentage Inspection

If for any reason the foundry practice was subsequently changed, a high percentage of X-ray inspection might be re-introduced at the inspector's discretion. The British report that this scheme has worked admirably, resulting in a remarkably accurate assessment of the soundness of stressed castings, in addition to a much-to-be desired uniformity in X-ray inspection methods.

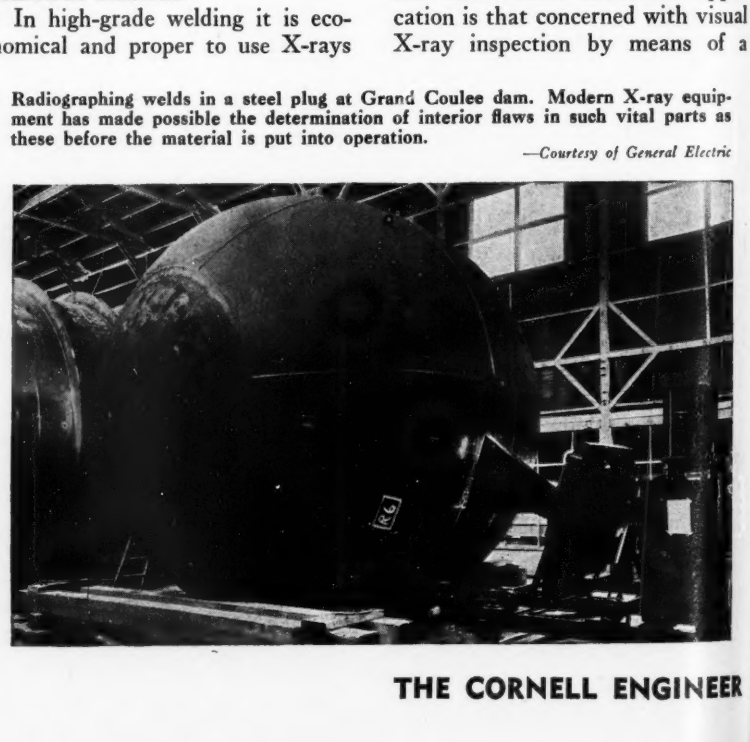
In common with almost all specialized branches of engineering, welding received a tremendous impetus under war conditions, and here again X-rays have become firmly established as an essential factor both in development and in routine inspection. Definite standards, such as those governing the acceptance of high-grade boiler welds, have been laid down by American concerns.

In high-grade welding it is economical and proper to use X-rays for 100% inspection. On the other hand, there are vast quantities of welding where this particular inspection technique would not be economical; where, in fact, it would not be possible owing to the complicated and difficult assemblies involved. In such cases it has become the custom, particularly in the aircraft industry, to use X-rays intensively during the training of a welder who is to be employed in special welding work. The initial efforts of the welder are subjected to every form of test that is possible, including, where convenient, a critical X-ray examination.

Another aspect of radiology that has considerable industrial application is that concerned with visual X-ray inspection by means of a

Radiographing welds in a steel plug at Grand Coulee dam. Modern X-ray equipment has made possible the determination of interior flaws in such vital parts as these before the material is put into operation.

—Courtesy of General Electric



fluorescent screen. Unfortunately, in most engineering applications, particularly those connected with heavy engineering, it is impossible to use this method. Where the specimen to be examined is light and thin enough to permit internal details to be shown on the screen the sensitivity is extremely low when compared with radiography.

This method has been used, for example, for the examination of the assembly of spark-plugs. The increased use of plastics will also offer opportunities for visual X-ray inspection.

Crystallography

X-ray crystallography has come into prominence in recent years particularly as applied to powder metallurgy.* This is a process by which intimately mixed metal powders are pressed into various shapes and subjected to a heat treatment called "sintering." During this treatment the powders diffuse and alloy in powder form below their melting points to recrystallize and grow in grain size. X-ray diffraction methods have been of immense value in checking the compositions due to these sintering reactions.

Analysis of Compounds

Another valuable application of X-ray diffraction methods is in the rapid analysis of crystalline compounds. The card index of the American Society of Testing Materials provides rapid means of positively identifying more than 1,000 different chemical compounds from their diffraction patterns.

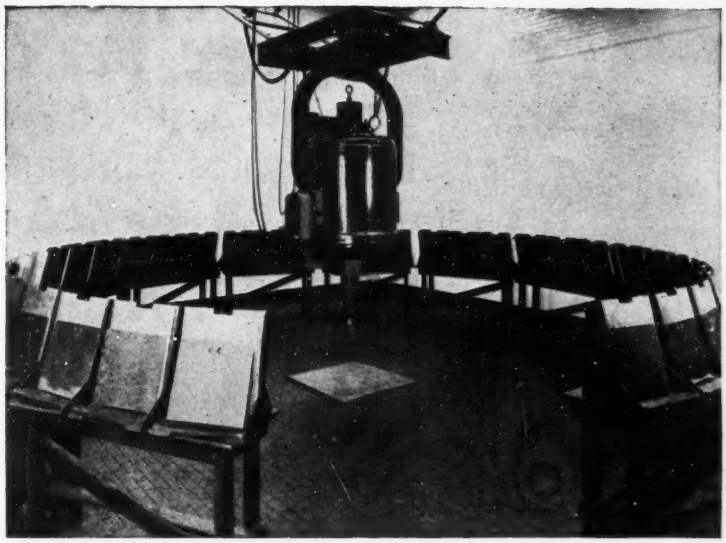
In general, chemical analysis only gives information as to the elements present in a compound, but X-ray methods give the state of combination of these elements. If they can exist in more than one form, it is possible to distinguish which form is present.

For many years after Roentgen's discovery of X-rays there was but little development in the elementary apparatus of evacuated glass envelopes and a Crookes or Hittorf tube energized by means of an induction coil. A revolutionary step was that taken by Dr. W. D. Coolidge when he invented the first hot-cathode X-ray tube utilizing tungsten as an electron target, from which X-rays were emitted.

In 1923, Philips in Holland introduced a "protected" X-ray tube in which the center of the tube was covered by a lead cylinder, the X-ray beam being allowed to emerge through a transparent window. In 1928 a protected, earthed, sheathed tube was introduced, and this type with its various modifications is the standard instrument in use today.

Marked Improvements

Improvement in design of electrical X-ray equipment with regard to weight, shape, and efficiency has been very marked during the past three years. Early in the war the General Electric Company placed 1,000,000-volt X-ray equipment on the market. From the point of view of its use for engineering and industrial purposes, perhaps the most important feature of this equipment is its mobility and maneuverability. One of the most vital factors in successful radiography is the correct alignment of the X-ray beam, which can be achieved only if the equipment is easily and accurately adjustable.



—*Courtesy of General Electric*

Mass production has been extended into the field of inspection by X-ray. These tables and fixtures are arranged for simultaneous radiography of many castings at a turbosupercharger factory.

The generating unit makes use of a low frequency resonance transformer which is coreless and insulated by compressed gas. The secondary or high-voltage coil is split up into 125 thin, flat sections, not bound together, but mounted apart, for cooling purposes. The resonance principle requires but a small input of power, some 3.5 kilowatts, the resulting current being delivered at one million volts.

Apparatus Description

Total weight of the apparatus is 1500 pounds. The transformer and tube are insulated by means of Freon gas, in contrast to the oil insulation commonly used. The 30-inch X-ray tube is made of borosilicate glass in 12 sections, and is 3.5 inches in diameter. At each section is mounted an accelerating electrode of stainless steel. The diameter of the focal spot is normally 7/8 inch, but this can be changed at will by means of a magnetic focusing coil placed around the chamber. The tube can be operated over a range of current up to three milliamperes, the size of the focal spot depending upon the current.

The X-ray tube is mounted coaxially in the center of the high voltage coils of the transformer. A

(*Continued on page* 34)

* See "Powder Metallurgy," *The Cornell Engineer*, Vol. 10, No. 8, 1945.

Engineering At Cornell

10. Physical Chemistry

By BILLIE P. CARTER, ChemE '49

ALTHOUGH it is said that chemical engineering is applied physical chemistry, physical chemistry professors and instructors in 410 agree, with a wry smile, that their course is not too popular with the chemical engineers. Whether or not physical chemistry has bad effects on the chemical engineers' peace of mind, it is a required course and a necessary evil. Course 410 is the laboratory course which follows closely the material given by Professor Briggs in his 405 lectures.

Place of Physical Chemistry

The chemical engineer begins phys chem, as it is popularly called, in his fifth term. By that time he is supposed to have completed the necessary background for 410, having had labs and lectures in inorganic, qualitative analysis, quantitative analysis, and organic chemistry, besides fourteen hours of physics and twelve hours of calculus and differential equations.

—*Deutch*

Co-ed using analytical balance

Physical chemistry is a coordination of three fundamental sciences —physics, chemistry, and mathematics. Although each branch can never be separated from the other even in the most elementary courses, still there is not too great a tie-up for the chemical engineer until he takes phys chem. In the prerequisite chemistry courses, many basic laws are stated and proved with experimental data obtained by other chemists. In physical chemistry the student, as the true scientist does, actually proves the laws which he has learned, and been told to accept, in his elementary courses.

Students making surface tension test —*Deutch*

Fundamental Laws

The laws discussed and demonstrated in physical chemistry are some of the very fundamental laws which guide the chemical engineer in industry. Perhaps the most important laws every engineer must be familiar with are the laws of thermodynamics. Two-thirds of phys chem's experiments have to do with the first two laws: conservation of energy, and the entropy concept (energy never flows from a low to a high level). This latter concept is especially interesting in that it proves the perpetual motion machine to be impossible. All engineers must be well-acquainted with heat and its effects; a chemical engineer must be particularly cognizant of chemical heat reactions, such as heats of formation (exothermic or endothermic), in order that he may design the proper equipment to house the full-scale manufacture of his reaction product. This thermochemistry is demonstrated in experiments concerned with heats of hydration, temperature coefficient of reaction velocity, and other reactions.

The speeds of reactions are included under a special topic, chemical kinetics. This study of rates of

(*Continued on page 22*)

PROFILES

Of Outstanding Alumni

Walter L. Maxson, M.E, '15

MINING has been well described as the peripatetic industry—properly so because unlike other expanding industries, the wasting assets of mining in the form of ore lead to the migration of the industry and those engaged in it.

There have been relatively few among Cornell graduates who have embraced this profession, although for a few years the mining option was offered by Sibley College. It was sponsored by D. S. Kimball and H. Reis, both of whom had some experience with mining. Their conception of the training required for success in this field has been amply demonstrated as sound.

Among those who graduated from the mining course was Walter L. Maxson, who has followed the profession for thirty years with some degree of success, although he has lived up fully to the peripatetic nature of the industry.

His experiences during that period have taken him to many fields in this country and abroad, gaining for him the recognition of becoming a metallurgist of national and international prominence. An incident which at the time carried no great significance but which later assumed great importance and captured world wide interest was the research, design and construction of a plant at Great Bear Lake in the Arctic circle in which Maxson participated and which became an important source of uranium for the atomic bomb.

Born in Cortland, New York, where he received his elementary education, he enrolled at Cornell in 1911. Taking advantage of the mining course, he earned the degree of mining engineer, which was conferred upon him in 1915. The first phase of his career embraced six years in the field of operation and research in the United States and foreign countries with Anaconda Copper Mining Co., Amalgamated Zinc Co., Phelps-Dodge and New Jersey Zinc.

In the following six years his background of experience in mining, mineral dressing, hydro- and pyro-processing of both metallic and non-metallic ores and minerals attracted the Colorado School of Mines, where he served as associate professor of metallurgy. During this period he took his Master's degree in metallurgy.

In 1927 he entered the commercial engineering field, joining the Allis-Chalmers organization as engineer in the mining department and later was advanced to chief engineer. From that time on, promotions came in rapid succession, progressing to sales manager and chief engineer of the mining, crushing and concentration division, and eventually he became manager of the basic industries division, embracing engineering and process development work for such various industries as ferrous and non-ferrous mining; metallurgical, cement, chemical and wood products; grain and cereal milling and vegetable oil extraction.

The industrial process research laboratory at Allis-Chalmers was developed under his guidance from a small operation started by him in 1927. From this laboratory have come improved techniques and basic data for many industries. It is one of the outstanding laboratories of the nation, serving clients throughout the world.

Maxson has participated in the development of gold mines all over the world—ranging from Arabia through Indo-China and the Philippines to Chile and South Africa; uranium ore at the Arctic circle; tin in Bolivia and the East Indies; bauxite in the Guineas; copper, lead and zinc throughout the world; and in the early war years, active participation in the development of concentration plants for iron ores in Alabama and the northeastern district including the Adirondacks.

During thirty years of intimate contact with many industries, his work has combined management, consulting, research and sales. However, in addition to this his capable energy has found him time to carry on original investigation into specialized fields. He is a recognized authority in the field of ore dressing and has various scientific articles and patents to his credit.

In 1944 the U. S. Steel Corp. inaugurated a long range research program under the auspices of their subsidiary, the Oliver Iron Mining Co., to improve their raw materials. The success of this program is of national importance because the Great Lakes Basin and its contiguous areas, which is prominent as the world's greatest manufacturing area, depends upon quality iron ore for steel production. The heavy drain of the war years has reduced considerably the known ore reserves and in planning for the future, it is recognized that the enormous tonnages of low grade ore existent at the head of the Great Lakes must be processed and made merchantable for the steel-making facilities at lower lake ports.

The mining subsidiary made plans for the establishment of a large research laboratory at Duluth, Minnesota, center of the head of the Great Lakes mining area. In searching for a capable and experienced engineer to carry out an extensive research program and head this important department, Cornell alumnus Maxson was selected for its director. The new research laboratory is scheduled to go into full operation shortly after the first of the year.

Mr. Maxson

PROMINENT

Biss —*Deutch*

Roger Bissinger, EE

THOUGH few over in Franklin Hall are aware of it, there is a future radio executive wandering through its halls. "Presidency of RCA" seems to be the pinnacle of success desired by Roger Bissinger. With that distant goal before him, Roger or "Biss" as he is usually called, has struggled through seven terms in the once ivy clad halls of Franklin, and is one of those eagerly awaiting a B.E.E. in communications next February.

It was back in September 8th, 1925 that the city of Philadelphia welcomed its newest arrival. "Biss" attended Cheltenham High School in Elkins Park, near Philadelphia, and was quite active in athletics. Among his accomplishments were a year of Varsity football, one of varsity wrestling and three years of track, during which he won the Pennsylvania Interscholastic Athletic Association, District I, discus championship. Athletics didn't consume all of Roger's time, however, for he was quite active in the scouts, becoming an assistant scout master, and somewhere along the line he even became an "honorary" Rotarian.

Biss was among the flock of new arrivals on the first of June 1943 in the new V-12 program. Once at Cornell, Biss soon became used to the many hills and started to look around for extra curricular activities. He continued his track career, getting in three seasons of Big Red varsity track and this fall made the soccer term. He confined his efforts in track to the weight events, excelling in discus throwing.

On the academic side of the ledger, Biss is a member of Eta Kappa Nu, EE honorary. He also belongs to the AIEE, the Flyers Club, and is secretary of the Spiked Shoe Track Society. Strange as it seems, his favorite subject is mathematics, which he would have liked to major in. When asked about his views of Cornell, Biss gives the following answer, "It's a beautiful place. I'd like to be here when Cornell has its new Engineering campus."

As to Roger's future, as with most graduating V-12's, it is still quite a lot in the hands of the Navy. However after his Navy life, Biss would like a good technical job in radio engineering, with the afore mentioned presidency in mind as he says he does have some stock already in RCA. After accumulating his fortune, Biss plans to build a "long, stone, two-story house with casement windows and built-in garage." Thus is undoubtedly for the future wife whom Biss has to have by 1952 to collect on a bet with his roommate—an admirable reason.

Alan Sutherland, EE

"I ONCE heard an arts student defined as one who spends his time learning less and less about more and more until he knows nothing about everything in general, while an engineer is one who knows more and more about less and less until he knows everything about nothing at all. But then, what's that got to do with the price of elephants in China?"

Such was the nature of the reply which we received when we approached Al Sutherland for an interview with that slightly worn question "Why did you choose Electrical Engineering?"

"I'm not exactly sure why I did choose EE, rather than one of the other types of engineering, but I'm certainly glad that I did. I find it the most fascinating, if not shocking, science that I have ever come in contact with." (We didn't think that it was a good pun either.)

Al is among the remaining handful of the first group of V-12's that came to Cornell. He came directly from Suffern High School with the ink still wet on his diploma, and a shiny new Bausch and Lomb Science Award plus the Rensselaer Award for Mathematics and Science, wearing holes in his pockets. His first impression of Cornell was its hills, as he and approximately 700 other pieces of "officuh material, suh" marched up Buffalo street after a grimy ride on the Lackawanna "Special" from Hoboken. Since then Cornell has seen quite a lot of Al and vice-versa.

During his stay here he has managed to make the Dean's List on and off (Al says more off than on). He became a member of Eta Kappa Nu in his Junior year and was initiated into Tau Beta Pi last term. He is also a member of the Phi Delta Theta fraternity. At present, he is chairman of the student branch of the AIEE.

"I guess the Navy has a few ideas about my immediate future," said Al, "but when they finally give up all hopes, I want to get a job with one of the large electrical manufacturers, preferably in the communications line, and put a little of this knowledge that I've supposedly acquired into practice. What I need now is some experience, and the more, the better."

Al —*Deutch*

ENGINEERS

John Gnaedinger, CE

When the small civilian class of '47 entered Cornell in the summer of 1943, they were outnumbered ten to one by the first contingent of V-12 trainees. But among these men in sports' coats was one who was destined to become a leader of the sailors and civilians alike, not only in the School of Civil Engineering, but on the entire Cornell campus. This freshman, and I assure you, he was not in any sense green, was John Gnaedinger.

John came to Cornell unusually prepared for college life. In attending over a dozen primary and secondary schools in such cities as San Francisco, Pittsburgh, Boston, Cleveland, and Oak Park, Ill., he was able to acquire a breadth of viewpoint on education that has helped him plan, with only occasional doubts, just what he desires to get out of education. Nor are his plans all in the professional line. John tells us that Civil Engineering has been his choice for a life's work since he acquired a sense of reason and an Erector Set, both on his seventh birthday.

As a freshman, John started out his college career with a bang. He made the varsity squad—the only freshman on the team, and earned a Cornell "C" for his efforts. As Cornell's only living bassoonist at the time, he played his "snoring bedpost" in the band and orchestra, and even trotted downtown to play with the Ithaca College Orchestra on several occasions. The Willard Straight Social Committee and the Newman Club took more of his time, but still he managed to lead the School of Civil Engineering in scholarship.

A new major interest came into his life at the start of his sophomore year, when he pledged Sigma Chi. In fact, he found himself the only active member on the Hill in the summer of '44. Since that time, John has held practically every office in the fraternity, including the presidency for a year. This fall he was elected Treasurer of the recently reestablished Interfraternity Council, which is indicative of his popularity with all the fraternity men at Cornell. The aim, John says, of fraternity life is to develop college students socially, a development which is so lightly brushed aside by altogether too many college leaders and students alike. It emphasizes versatility, and promotes school spirit.

The fall of '44 found John wearing a Junior Blazer. He was honored at this time by invitations to membership in Tau Beta Pi, Chi Epsilon, Pyramid Society, and Beta Upsilon. Don't ask how Beta Upsilon got in there. If you know John, you know why. He argues that he's merely trying to help keep part of our Cornell tradition alive, which he is definitely doing. He's the man with those songs we all wish we knew.

(*Continued on page* 26)

John —*Deutch*

Edward Atherton, EE

On the first of July, 1943, a sandy-headed frosh attired in a "sharp" civvie outfit, stood on the steps of the Straight bewildered by the vast size of Cornell University. This confused young man who had just been transplanted from the heart of the Middle West, Kansas City, Missouri, was Ed Atherton. His happy civilian days lasted only until the following July when he joined the Navy and was assigned to the V-12 unit here.

Ed

Numerous people have asked "Smilin' Ed" why he selected Cornell. His only answer is that he wanted to see what it was like "back East." He takes quite a little kidding about his home town being "way out in the sticks," but Ed assures us that the folks back home wear shoes.

This past football season "Smilin' Ed" has been the right hand man of "Smilin' Ed" McKeever. Ed managed the football team with efficiency and finesse that will long be remembered at Schoellkopf. This was the culmination of two years' work as a compet and assistant manager. In addition he has been serving as the secretary-treasurer of the Football Club for the past year.

The first two terms of his college career were spent under the direction of the M.E. School, but Ed outgrew his childish fancies at the end of his freshman year and switched to E.E. Since then Ed has been an enthusiastic power-man. At the end of the present term Ed will receive his B.E.E., and according to present Navy plans he will then be commissioned as an ensign.

Ed's post-Navy plans are to spend a couple of years working in the General Electric Laboratories. He then wants to return to Kansas City and get into some work connected with Electrical Engineering. Ed's skillful management of the football team and the sound common sense he has displayed in his engineering work point the way to a successful future.

Recent Developments In Engineering

Techni-Briefs

Matter From Energy

ANNOUNCEMENT has recently been made of a Propjet which opens a new field in propulsion developments for both military and civilian aircraft. This light engine is the No. 1 gas turbine to both drive an airplane propellor and boost with jet propulsion. The Propjet which functions efficiently and economically when producing full power continuously during long flights, was developed for the Army Air Forces by General Electric engineers to drive large bombers and military transports. Engineers are confident that this type of engine will be harnessed extensively to power large civilian aircraft.

Hi-Speed Radiograph

ONE microsecond is the energy factor required for millionth-of-a-second X-ray exposure—pictures so fast that they can disclose the behavior of a bullet as it travels down the barrel of a machine gun. The electronic tube which makes such speedy radiographs possible, shown at the Westinghouse Lamp Division where it was developed, is mounted on the front end of the surge generator. To attain the enormous sudden burst of 600 million watts of electricity necessary to make these exposures, energy is stored up in six condensers which discharge in one simultaneous, crackling surge of electricity when the operator presses a button.

Mathematical Wizard

THE long series of mathematical computations which have been necessary in solving the intricate problems involving the location and arrangement of radio towers are replaced by a new electronic device called the Antennalyzer, Dr. George H. Brown of RCA Laboratories announced at a recent meeting of the Washington, D. C. Section of the Institute of Radio Engineers.

Field tests and calculations, which formerly required weeks to perform, are now done in a matter of minutes by this electronic computing machine which adds and subtracts angles, multiples, looks up trigonometric functions, adds numbers, squares them and finally takes the square root of the whole to produce the desired answer, which the engineers must have to accurately locate a directional antenna.

The Antennalyzer—a new magic brain in the field of radio—consists of 52 electron tubes. The associated circuits can be adjusted to duplicate all characteristics of a projected antenna. In operation, the controls of the machine are regulated until a pattern of light on a cathode ray tube is identical with the desired pattern of transmission of the broadcast station. Final dial readings not only tell where to locate the towers, but give all electrical data needed to complete the most efficient antenna design.

New Type Camel

TO prevent damage to ships while loading, a new type cylindrical camel of laminated oak has been developed. It has wide possibilities for use by shipping, towing, and

(*Continued on page* 28)

A view of the new electronic tube —*Courtesy of Westinghouse*

NEWS OF THE COLLEGE

Enrollment Breakdown

CORNELL University's fall term enrollment of 6679, which includes 1249 veterans, almost equals 1940's all-time high enrollment of 6800 at the University. Late registrations during November are expected to narrow the gap further with a predicted enrollment of approximately 6750.

The present enrollment includes 2118 women students on the Ithaca campus and 298 women at the Medical College and School of Nursing in New York City. Of the 1249 veterans in Ithaca, 5 are women.

Undergraduates in uniform total 1025 which include 227 in the V-12 program, 206 in V-5, 109 Marines, and 483 in the new NROTC program. Nearly 500 of this group are in the College of Engineering, 436 in Arts and Sciences, and the balance scattered throughout other colleges and schools of the university. There is also a small class in Diesel Engineering.

Present civilian enrollment totals by colleges are: Architecture 104, Arts and Sciences 1625, Engineering 876, Hotel Administration 170, Graduate School 550, Law 90, Agriculture 786, Home Economics 600, Industrial and Labor Relations 107, Veterinary 118, Medicine 314, Nursing 270.

Chemistry Fellowship

A GRADUATE fellowship for work in the chemistry and chemical engineering of wax has been established at the Cornell University by S. C. Johnson & Son, Inc., Racine, it was announced recently by Dr. J. V. Steinle, Research and Development Director for Johnson's Wax. Cornell is one of six universities in the country selected for the grants because of outstanding work done in the field of wax research. The grant will be for $7,500 to finance study under the direction of Prof. F. H. Rhodes.

RAYMOND T. Henry, at a recent meeting in Franklin Hall, of the Ithaca and Cornell chapter, American Institute of Electrical Engineers, delivered an address on the "Niagara Hudson Power System." Mr. Henry is chief electrical engineer for the Buffalo, Niagara and Eastern Power Corporation, and vice-president, District No. 1 of the AIEE.

Tau Beta Pi

TAU BETA PI, engineering honorary society, held a banquet at the Alhambra at the end of last semester, in honor of their new initiates. The guest speaker was Professor Gibbs of the Physic Department, who spoke on "The Atomic Bomb."

The newly elected members are as follows:

Donald Beaumariage, Owen J. Black, Theodore J. Bliss, Frohman P. Davis, Ralph W. Detra, Robert E. Heath, Richard W. Jordan, William H. Mutschler, Jr., William V. Phelps, Harold B. Radcliff, William J. Rea, Robert J. Rubin, Anthony S. Rugare, John M. Schultz, Raymond H. Schumacher, Varick Schwartz, Robert B. Seidel, Alan D. Sutherland, Thomas E. Talpey, Edward A. Thimons, Paul F. Weaver, Jr., William J. Weigle, William H. Wilder.

The group is planning to hold elections soon and is making preparations for a cocktail party to be held in December.

Chi Epsilon

CHI EPSILON, Civil Engineering honor fraternity, is planning a banquet to be held in December in honor of their new members, both those elected at the end of last term and those men who will be pledged shortly.

Eta Kappa Nu

A number of new men have been recently initiated into Kappa Chapter of Eta Kappa Nu, electrical engineering honorary society. Those initiated since the last news item are:

D. C. Beaumariage	H. Harper
W. R. Richardson	W. Mutchler
R. W. Kaemmerer	R. Bissinger
C. W. Coleman	W. Truesdell
G. W. Hallgren	P. F. Weaver
L. W. Simmons	J. W. Toner
R. L. Hunicke	L. Slaughter
W. R. Davies	C. R. Fisher
W. H. Wilder	A. L. Koup
W. J. Weigle	A. B. Levine
C. R. Heising	G. R. Bosley

New officers of the society are:

President—T. J. Bliss.

Vice Pres.—R. W. Johnston.

Corresponding Secretary — T. Talpey.

Recording Secretary — L. W. Simmons.

Treasurer—D. C. Beaumariage.

A banquet was held recently at the Alhambra. Prof. Robinson of the Law School was guest speaker. Future plans of the organization include a smoker to be held shortly.

Pyramid Society

AT a recent meeting of Pyramid Society, John Gnaedinger was elected president, John Collinson vice-president, and Peter Verna secretary-treasurer. They held a pledge party on November 20, and are planning a party at Mt. Pleasant for members and new pledges.

Rod and Bob

NEWLY elected officers to Rod and Bob are: Gilbert Holmberg, president; Dick Pitropoali, secretary-treasurer; and Jim Becket, "Keeper of the Keg"; all of whom are in the Navy V-12 program.

The Engineer Takes A Bow

AT the Engineering College Magazines Association convention held at Ohio State University this summer, the CORNELL ENGINEER received five awards, given in the following classifications.

Best Single Article, Second Place; Best Alumni Section, Second Place; Best Illustrations, Third Place; Best Student Articles, Honorable Mention; Best Cover, Honorable Mention.

DONALD J. Shank, for over ten years administrative associate to the president of the American

(*Continued on page* 24)

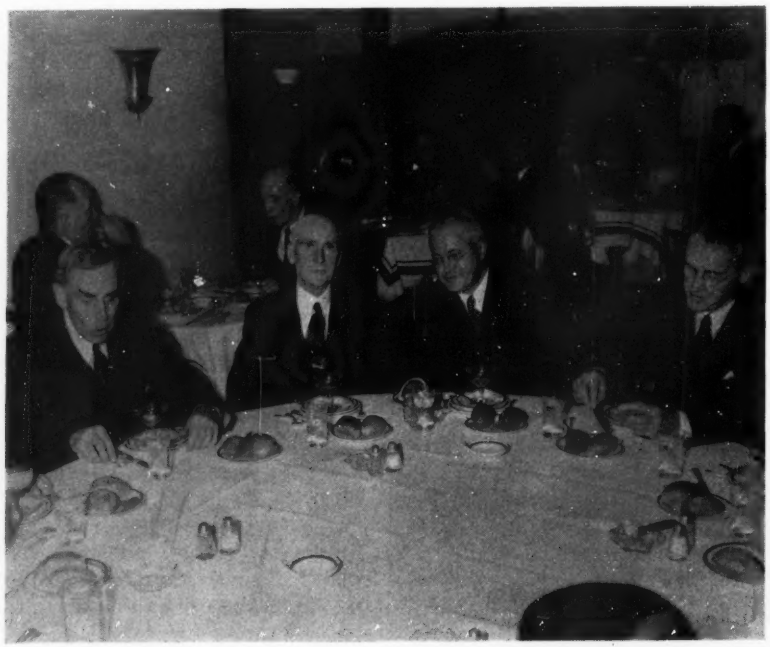
ALUMNI NEWS

Dean Kimball Is Eighty

CORNELL SOCIETY OF ENGINEERS arranged a birthday dinner celebrating Dean Dexter S. Kimball's eightieth anniversary, at the Cornell Club of New York October 18. Dean Kimball was eighty October 21.

One hundred Cornellians and other prominent engineers attended the party. After dinner, J. Paul Leinroth '12, president of the Society, introduced Dean S. C. Hollister, Engineering, and D. Robert Yarnall of Philadelphia, Pa., president-elect of the ASME. They told of Dean Kimball's long leadership in engineering and education. Hale and hearty, Dean Kimball spoke humorously of his feelings at being eighty, and told of some of the things he has yet planned to do. He has again started his course of ten weekly lectures on industrial management at the post-graduate school of the U. S. Naval Academy, which he has given there the last two winters. This year he teaches 400 young officers.

(In the cut, seated around the table in the foreground from left to right are: Harvey N. Davis; Pres. Steven's Inst. of Technology, Dean Kimball, J. Paul Leinroth '12; Pres. Cornell Soc. Eng., and D. Robert Yarnall; Pres-elect ASME.)



MAJOR STEPHEN K. L. KAY, B.M.E. '40, has received the Legion of Merit in recognition of "exceptionally meritorious conduct in the performance of outstanding services in the Middle East," from November 1, 1942, to September 1, 1945. He is now in the United States after thirty-six months in the Africa-Middle East Theater where he was assistant inspector general.

His citation commends the "tact and determination" he displayed in securing permission from the Egyptian government to move several hundred skilled Polish workmen from Palestine through Egypt to Eritrea, where they were urgently needed to work in the newly-formed Arsenal. His plan, used by the U. S. Military Mission to Saudi, Arabia, for the modernization of the Saudi Arabian army also received high commendation.

PERLEY S. WILCOX, M.E. '97, chairman of the board of the Tennessee Eastman Corp., has been elected chairman of the board of directors of the Eastman Kodak Co., Rochester. He joined the Kodak organization in 1898, working first on the development and design, and later, on the installation of a continuous process for manufacturing transparent film base. In 1901 he became superintendent of the roll-coating department, and in 1906, assistant general manager of the plant. When the Tennessee Eastman Corp. was established after World War I, he went there as general manager, later becoming president. Last January he was elected vice-chairman of the board of Eastman Kodak Co.

HENRY L. MOELLER, C.E. '07, has been reappointed by Governor Walter E. Edge a member of the council of forests, geology, parks, and historical sites of the New Jersey Department of Conservation. Gov. Edge on September 13 presented to Mr. Moeller the New Jersey Distinguished Service Medal "for exceptionally meritorious and distinguished service for more than thirty years in the calvary of the National Guard in all grades." He is also chief engineer for the Jarka Corporation of New York City.

HAROLD E. KNEEN, M.E. '25, has been named vice-president in charge of manufacturing for the Lincoln Electric Co., Cleveland, Ohio. He joined the company in 1929 as assistant plant superintendent, and was promoted to general plant superintendent in 1931.

Mr. Kneen is a member of the American Welding Society, Mayfield Country Club, and Mentor Harbor Yacht Club. His chief hobby is sailing a new type of sloop known as the "Great Lakes 21" which he was instrumental in designing.

MAJOR THEODORE C. HEINE, E.E. '29, is commanding officer of the 52nd Army Airways Communications System Group with headquarters at Reading (Pa.) Army Air Field. The Group is responsible for operating and maintaining radio aids to aerial navigation over U. S. Army Airways at approximately fifty air bases in twenty Northeastern states.

NORMAN M. BARRETT, '42 B.S. in A.E. (M.E.), who is overseas with the 8th Army Air Force, has been promoted to major.

(*Continued on page 26*)

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SYLVESTER J. McKELVAY, *Vice-Pres*.....174 North Arlington Ave., E. Orange, N. J.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

Mr. Leinroth

President's Message

AN event significant to all Cornell engineers, wherever they may be in the world, was the eightieth birthday of Dean Emeritus Dexter S. Kimball on October 21st. On October 18th the Cornell Society of Engineers gave a dinner in his honor at the Cornell Club of New York. His appearance, keenness and general demeanor certainly belied his eighty years. As he addressed us he seemed to me little different than when he lectured to us in Sibley more than thirty years ago. The same simplicity, the same human touch was there; he held us under his spell just as he did in those days.

As he reminisced one could not but feel deeply that it is such teachers as Dean Kimball that make great universities, and that it was as a great and inspiring teacher that Dean Kimball made an outstanding contribution to the greatness of Cornell. Cornell needs more men of his stripe as do all great universities. Not only was he an authority on his subject and had unusual ability to impart his knowledge to his students but he did it with a rare charm of manner and richness of understanding that left its imprint on all those who attended his lectures.

Dean Kimball has lived a full life being at once an outstanding citizen, a great and inspiring teacher and an engineer who reached the pinnacle of success in the engineering profession. He has served the university almost continuously since 1898 in various capacities. Being called to Cornell in that year as Assistant Professor of Machine Design he brought to his students a wealth of experience which he had acquired largely while with the Union Iron Works in San Francisco where he was connected with some of the most important engineering projects of his time. He was early impressed with the importance of offering instruction in industrial economics and management to engineering students and was one of the country's early pioneers in setting up such courses at Cornell. His contributions in that field of engineering education were outstanding.

In 1920 Dean Kimball became the first Dean of the newly unified College of Engineering and it was under his leadership that the college was organized. Twice he has served as Acting President of the University. He has been granted honorary degrees by several institutions and medals of honor by scientific and engineering societies; he has been called by other well known universities to lecture, and carry on and establish courses of instruction; he is the author of text books which have served for years as standard in their fields; he has been President of such great engineering societies as the American Society of Mechanical Engineers, the Society for Promotion of Engineering Education, and the American Engineering Council.

In civic affairs he was equally active. During World War I he was United States Fuel Administrator for Tompkins County; he has been a Director and President of the Ithaca Chamber of Commerce as well as President of the Ithaca Community Chest. During the recent war he was a dollar a year man as Tools & Equipment Executive—Priority Division of the O.P.A. in Washington. He has been a member of the Alexander Hamilton Institute Staff and a Director of the McGraw-Hill Publishing Company.

But notwithstanding all the honors that have been bestowed upon him by others, we Cornellians like to think of Dean Kimball as the professor "on the hill"—as one with rare professional ability coupled with a human and sympathetic interest which he used without stint on behalf of his students. He epitomizes our ideal of a great teacher. He easily takes a front place in the ranks of those immortals who have added lustre to the name of Cornell. He will always be remembered with reverence. We delight in the excellent state of his health and general mental vigor. That his coming years may be full of the happiness which he so richly earned is the sincere wish of every Cornellian.

J. PAUL LEINROTH '12

MAGNESIUM

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Physical Chemistry

(*Continued from page* 12)

reactions is also of great practical importance. Whether or not a reaction will give a product in a couple of hours or a few years is vital to the chemical engineer and the company for which he works. In course 410 an interesting experiment is carried out with the inversion of sucrose. Using polarized light, with the aid of a Nicol prism, the speed and quantity of its conversion to fructose and levulose, is determined. Included in the study of chemical kinetics is catalysis, or the effect on the rates of reactions of certain chemicals, which do not change themselves in the process. Industrially, knowledge of catalysts is essential and very profitable; for example, the catalytic cracking of oil.

In physical chemistry the chemical engineer learns to save time with his qualitative and quantitative analysis. By using refractive indices, a very convenient method to obtain the chemical constitution of a substance is possible. Concentration of solutions is determined by conductivity in two experiments: conductivity and conductance ratio, and conductimetric titration. One very unique apparatus is the dropping mercury electrode, which was set up in the Cornell physical chemistry lab with home-made equipment. Nevertheless it turns out in a few minutes the quantitative and qualitative analysis, within 1%, of the constituents in a solution.

Phase-rule study is another subject which has great practical importance. Experiments on the Phase Rule have to do with a three-component phase system. In the lab the phase graphs are plotted from the student's own experimental data. This is one example of the student's actually determining something he learned way back in introductory inorganic.

Another long set of experiments has to do with distillation, which is industrially very important. In 410, distillation of mixtures is studied, along with steam and fractional distillation.

Electrolysis and sources of electromotive force are also experimented with in phys chem. The students set up cells, and measure EMF's; they also measure the speed with which given ions migrate in an electrical field, and study one application of a phase of the Debye-Huckle inter-ionic attraction theory.

Other laboratory work includes experimental study of the PVT gas laws: molecular weight by vapor density, and vapor pressure of a liquid. Some physical variables which figure in the gas laws are also determined. Surface tension, read about in general physics, is actually determined by the ring method in phys chem. Another part of the course is devoted to the study of the physical properties of different states of matter.

The phys chem lab is located in the very depths of Baker—which sometimes gives rise to a chemical engineer's caustic quip. Equipment in the lab is standard and not spectacular, as it must be in any introductory phys chem lab. The number of students taking the course hit an all-time high of 160 in the first year of the war, and future classes will probably be that large, if not larger, because of the great increase in chemical engineering registration. Although more elaborate experiments are desired by the department heads, it is quite impractical with such large classes. For example, some experiments on X-ray use in chemistry are possible with small groups, who can be

(*Continued on page* 24)

Students determining vapor pressure with isotensiscope

—Deutch

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THE RIGHT BEARING FOR THE RIGHT PLACE

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Physical Chemistry

(*Continued from page* 22)

taught to understand the dangers and techniques of the apparatus. There would be no time to do this with the present-sized classes however.

Experiments used in the phys chem lab are a well-chosen representative group, some taken from various lab manuals, and others designed by the department itself. The department's general method is to let each student use his own initiative as much as possible in performing the experiments. The "cook-book" method of conducting an experiment is not allowed. To make sure of this, the student is quizzed on the extent of his preparation *before* beginning work on a new experiment. Besides this, a written report on each experiment is submitted by each student within a week after completing the experiment in the laboratory. In writing these reports, he is encouraged to refer to outside references to prove specific points, while keeping the writing as concise and terse as possible. In this manner the student becomes familiar with writing a report similar to one he would make if he were engaged in actual research.

Physical chemistry is an important step in the chemical engineer's course. After he has taken it, he has made his first step out of the realm of pure science into the world of over-all science—engineering.

College News

(*Continued from page* 17)

Council on Education at Washington, D. C., has been named director of student personnel of the New York State School of Industrial and Labor relations, which was opened November 1.

Mr. Shank's appointment was the third to be announced for the staff of the new school. Irving M. Ives of Norwich is the dean, and Dr. Phillips Bradley is director of extra-mural courses.

Miss Jeanette Poor of Medfield, Mass., has been appointed librarian of the College of Engineering, succeeding William H. Hyde, Jr., who has accepted a position at Illinois Institute of Technology. A graduate of Simmons College, Miss Poor also studied at Columbia. After serving on the staff of the John Crerar Library, Chicago, she was at the library of the RCA Victor Division at Harrison, N. J., before accepting the Cornell position.

Cornell has arranged, through the American Merchant Marine Library Association, to provide a complete library for our victory ship.

This newest group of 10,800-ton cargo ships is being named for American colleges and universities, which have a student body of 500 or more, in the order of their founding.

Bayard E. Quinn has been promoted to assistant professor of machine design in the College of Engineering. He came to Cornell in 1940 as an instructor in mechanical engineering, and received a Ph.D. last month. A graduate of Drexel Institute in 1937, he was associated with the Radio Corporation of America and the General Electric Co. before coming to Ithaca.

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● Fearful of being "too late with too little," American industry won its race against time. Quantity and quality surpassed the hopes of all but the most courageous and progressive.

One of the contributing factors to victory was the *general advancement in mechanical materials-handling,* and most particularly in routing materials in process through successive stages of manufacture. Substantial savings in manpower, time and costs accrued. Production consistently increased, meriting a steady flow of "E" awards.

Lamson Conveyors, through many ingenious applications, devised by Lamson engineers, showed industry throughout the length and breadth of the country, new speeds and economies in materials-handling.

The rewards of Lamson achievement are now available to you . . . and in practice are essential to the competition which is following reconversion.

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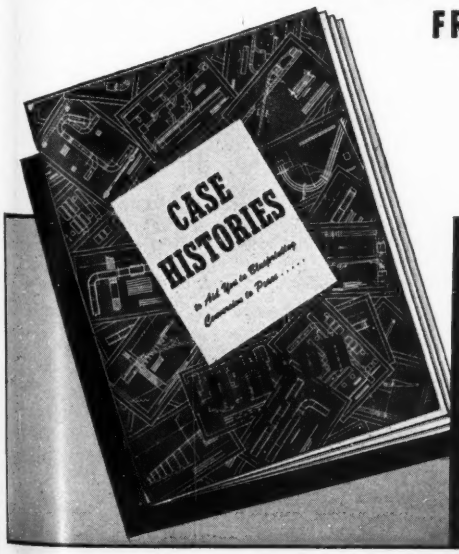

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College.....

Address.....

City and Zone.....State.....

John Gnaedinger

(*Continued from page* 15)

After taking a leave of absence this past summer, John is back to make his senior year at Cornell something to remember the rest of his life. He has been elected president of Pyramid, and was co-chairman of a committee for the December 8 semiformal. Engineers are already taking bets that his keychain has reached the yield point. John seems to find a certain fascination in keys of all kinds.

After graduation in June, John expects to take advantage of a fellowship offered him at Northwestern University Technological Institute, to do graduate work in the field of soil mechanics and foundations with a structures minor. Then he intends to aim at a position as a consulting engineer in these chosen fields.

Alumni News

(*Continued from page* 18)

HENRY C. GARRETSON, JR., M.E. '31, has been promoted to lieutenant colonel. He has been on the staff of the China Theater since last March as assistant G-3 (Operations), and formerly served in North Africa, Italy, and the India-Burma Theater.

LIEUTENANT BRUCE L. CORMACK, C.E. '39, who is home after almost three years as a prisoner of the Japanese, wrote a poignant letter to his family while aboard the ship bringing him to the United States. It is quoted in part:

"This is my first letter to you as a free man. My mind tonight is in such a welter of emotion that I find it almost impossible to express my thoughts coherently even to myself. The big fact that we are free is just now beginning really to penetrate home. This realization has manifested itself by an increasingly potent series of impressions and incidents starting with the day over three weeks ago when we received the order at our last camp (Rokurashi) to stop all work on our agricultural project.

". . . After five days of anxious speculation and suspense, aggravated by our idleness and the odd behavior of our keepers who were conspicuous by their absence, the now strangely humble Jap camp commander on August 22 notified our senior officers that the war was over and our departure for home imminent.

". . . Food and supplies of all kinds previously unheard of and unobtainable now poured into camp. Half-starved, we gloriously gorged ourselves and were gloriously ill. . . .

"The climax came September 2 when four B-29's rained food, candy, tobacco, clothing, and magazines down upon us by parachute. There were dangerously delectable parcels when 50 gallon steel drums filled with chocolate would break loose from the chutes and come hurling through the barracks roof. One Nip was actually struck and Lord knows how many POW's, including myself, were scared stiff by those thundering calories. . . .

"That afternoon we were notified that the Armistice was officially signed and we were no longer prisoners. We took over the camp, erected a flagpole and hoisted Old Glory to the accompaniment of the bugle. There were few dry eyes among Americans or Japs after that ceremony."

Sheffield Farms, New York

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Daniel M. Lazar, '29 — *President*
L. Sanford Reis, '29 — *Treasurer*

* * *

We can offer the Services of our Experienced Construction Personnel to help you Design, Prepare both budget and bid Estimates, and Build in this Post War Period

* * *

INQUIRIES ARE INVITED

Guess how many miles of thread he's wearing!

LET'S unravel the man—garment by garment! When we do, we find it takes about 58 miles of thread, of one kind or another, to dress him from the skin out.

Better than 9 miles for underwear; 2½ miles for socks; 10 for a shirt; 1 for a tie; 35 for a suit. So the manufacturers tell us.

And remember, every inch of *all* the thread that is woven into fabrics has to run at high speed through metallic guides on the textile machines. .

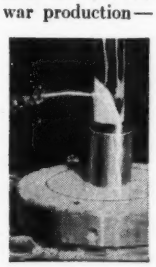
Those guides are ordinarily made of hardened or chrome-plated steel—but they wear out fast.

Now mill owners are turning to a new miracle metal, "the hardest metal made by man." It is called Carboloy Cemented Carbide. And mill men have discovered that Carboloy textile guides often outlast steel as much as 50 to 1.

What is Carboloy? It starts out as a simple mixture of metallic powders, but tremendous heat and pressure transform it into a metal of almost diamond hardness.

Industry's "Secret Weapon"

In cutting tools, in dies for drawing wire and tubing and forming sheet metal, it has played a major role in war production—commonly tripling the output of machines and men; speeding tank, ammunition and naval building programs.



After the war, the benefits of this new miracle metal will be available to everyone! Countless products will be made better and cheaper through the wider-spread industrial use of Carboloy tools and dies.

More than that, the use of Carboloy for wear-resistant parts in airplanes, automobiles, home appliances and equipment, will give these products themselves improved performance and longer life.

Attention Engineers and Designers

Carboloy research and field engineers will gladly help you take full advantage of the hardest metal made by man in planning your postwar product and production program. Write us today. Carboloy Company Inc., Detroit 32, Mich.

Even your clothes have felt the effects of a wonderful new metal—the hardest metal made by man. Carboloy Cemented Carbide has helped revolutionize industry—and promises great benefits to everyone in the near future.

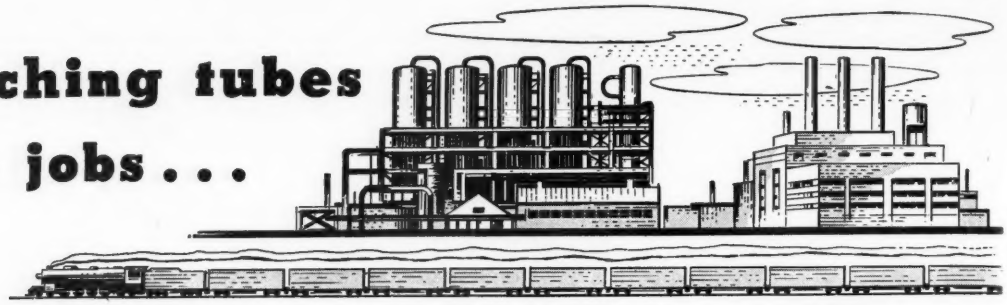
The Hardest Metal Made by Man

CARBOLOY

TRADE MARK

CEMENTED CARBIDE

Matching tubes to jobs . . .

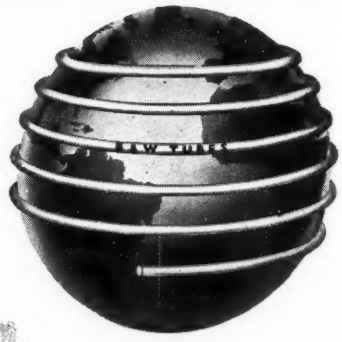


One of the major ways B&W can serve you in your engineering career is in matching steel tubes to jobs — to such diversified applications as stationary, locomotive and marine boilers; to high pressure high temperature services in refineries, synthetic rubber plants and other chemical processes.

Since B&W became the first boiler manufacturer to make its own tubes, nearly 40 years ago, it has produced enough pressure tubing—both seamless and welded—to wrap almost 6 times around the Earth. In addition, B&W has produced vast quantities of *mechanical* tubing, of both kinds, for machined parts and structural purposes.

Two specialty tube mills are operated by B&W today, with extensive physical, chemical and metallurgical laboratories for manufacturing control and continuity research.

B&W's *past* experience, plus *present* research, make B&W the name to watch for *future* tube developments.



Seamless Tube Division
Beaver Falls, Pa.

BABCOCK & WILCOX
THE BABCOCK & WILCOX TUBE COMPANY

Welded Tube Division
Alliance, Ohio

G 306

Techni-Briefs

(*Continued from page* 16)

wharfing concerns, and is claimed to be superior to the raft-type camel in general use.

The new camel is made of a series of split rings of laminated oak, joined by strakes of the same material in such a manner that it absorbs both compressive action and longitudinal rack. It is used as a separator between ship and wharf to prevent costly damage to the vessel. Unlike the raft-type camel, its circular shape eliminates danger of upending. The proportion of weight to strength is very small, thus permitting easy handling of the camel. It is light enough to be carried by davits or boom on wharf or barge. Repairs and replacement of parts is also comparatively simple.

The largest model produced so far is 26 feet long, and has a diameter of about six feet. It consists of 24 rings built up of quarter-inch laminae, and having a diameter of five feet. A split of about four inches acts as a shock absorber against compression. The amount of pressure needed to close this gap can be accurately determined. The bottom of the camel is weighted to keep it floating with the split at the top. The rings are joined by 16 strakes which are fastened to alternate rings. This allows play to absorb longitudinal pull. These strakes are built up of three-quarter-inch laminae, and connectors of special strength are used adjacent to the split, because the greatest strain is concentrated there. The camel weighs about 6 tons, but will absorb a pressure of 250 tons.

Dunking water-proof fly
—*Courtesy of Westinghouse*

Dry Flies

SILICONE oil, a revolutionary new product which is derived from sand and coal in combination with brine, is the answer to the fly-fisherman's prayer, according to G. L. Moses, Westinghouse Electric Corporation engineer, East Pittsburgh, Pa., who is conducting exhaustive tests on various new type silicone materials.

"A number of scientists, who are enthusiastic fishermen, have discovered that dunking the fly in silicone oil will keep it from getting wet for periods of time," said Mr. Moses. "Other oils have been used for this purpose heretofore, but did not adhere to the fly long. Because silicone oils are extremely water-repellant and because they will not freeze at 70 below zero F. nor break down at 300 degrees above zero F., they will stay on a dry fly for long periods of time."

Bowes Drive

A NEW electric device for the reduction of speed between modern high-speed prime movers and drive shafts for mechanical applications

(*Continued on page* 30)

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ITHACA OFFICE
SIBLEY DOME BLDG.
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Techni-Briefs

(*Continued from page* 28)

where gear and coupling combined are ordinarily necessary, has been developed by Thomas D. Bowes, M.E. '05, Cornell, naval architect and marine engineer of Philadelphia. It is being built in two types, reversing and non-reversing, by Elliot Company, Ridgeway, Pa., as licensee.

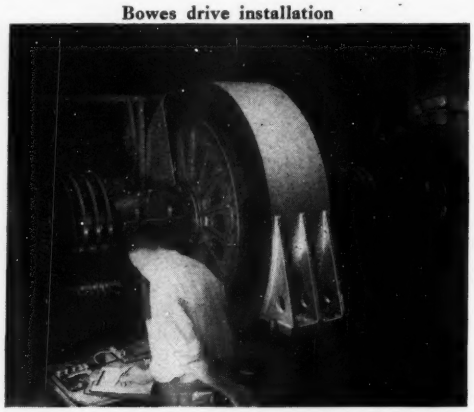
The engine element which is essentially a synchronous generator rotor with poles selected for the desired speed ratio, is permanently attached to the shaft of the prime mover and revolves at the normal engine speed.

The shaft element consists of a rotating spider on which two armatures are concentrically mounted in relation to the engine element.

The inner armature, together with the engine element, forms a generator. Its winding not only generates electrical energy but also transmits torque to the driven shaft of the Bowes unit.

The outer armature makes use of the field of the third or stationary element to operate as a motor, converting electrical energy into mechanical energy for turning the driven shaft.

Bowes drive installation



If the shaft element is held stationary, the inner parts of the Bowes Drive behave like an ordinary synchronous generator and electrical energy can be taken continuously from the drive. This is particularly advantageous on a ship propulsion system where large amounts of power are frequently required while the vessel is in port. In normal operation, of course, the shaft element rotates at the speed desired for the driven shaft. The relative speed between the engine field element and the shaft element adjacent to it results in the generation of electrical power. The reaction torque which in a normal generator would be absorbed by the frame

(*Continued on page* 32)

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Skis, Skates & Warm Clothing

That Means—

THE JUNIOR PROM
Dress Shirts, Ties, Collars
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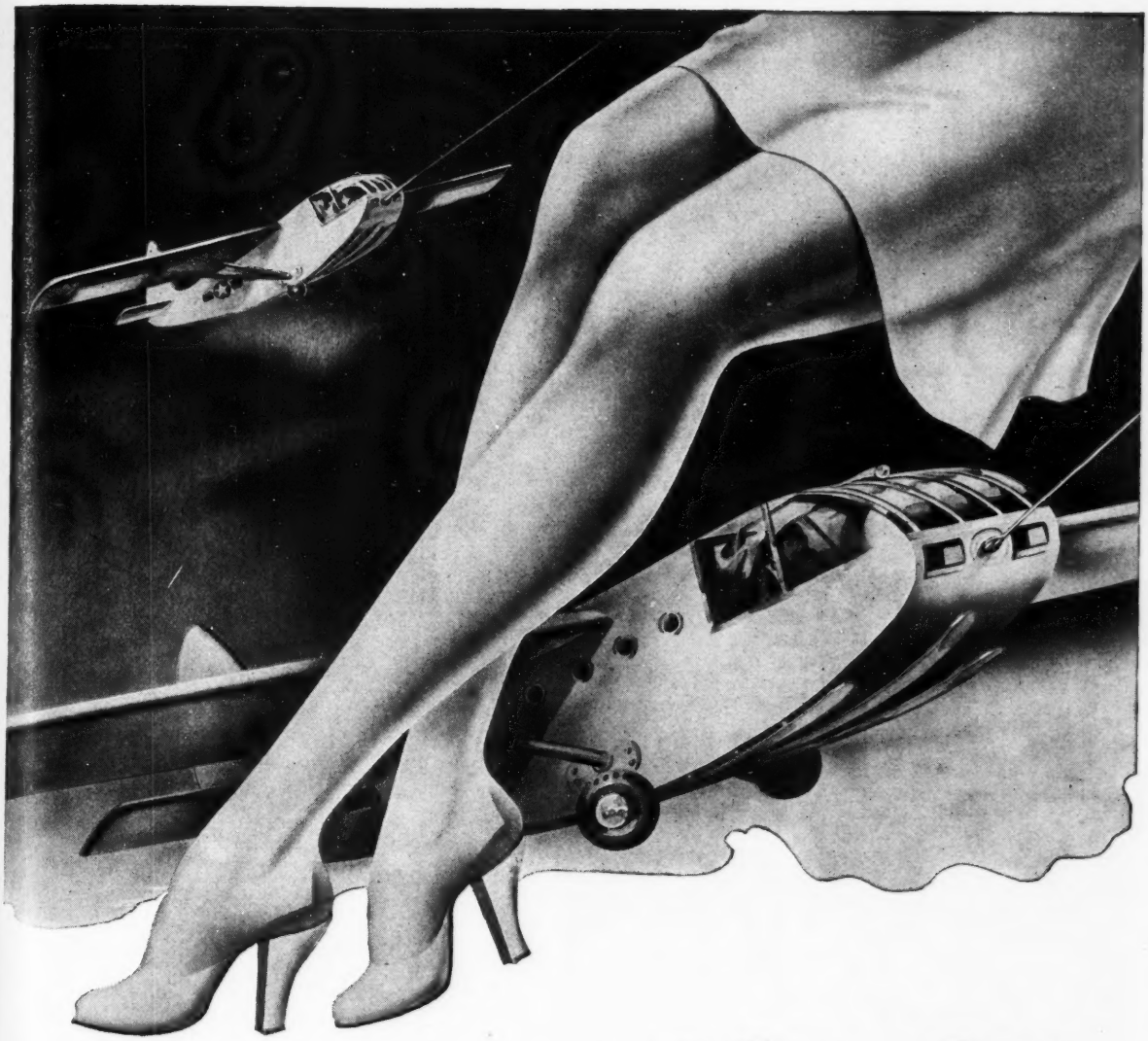
We are expecting, and getting, many registrations of Cornell veterans. They are welcome.



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That's the amazing range of products made from Calcium Carbide, the material that produces acetylene gas for welding and cutting. Now, through the modern science of chemistry, this versatile product has become a basic material for making a host of new things — plastics, rayon fabrics, cleaning fluid and synthetic rubber — for a thousand different uses.

National Carbide is one of many Air Reduction products that play an increasingly important part in diverse phases of American life . . . from aircraft manufacture to food packaging . . . oxygen therapy to shipbuilding.

The operating subsidiaries of Air Reduction Company, Inc., are:

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Techni-Briefs

(*Continued from page* 30)

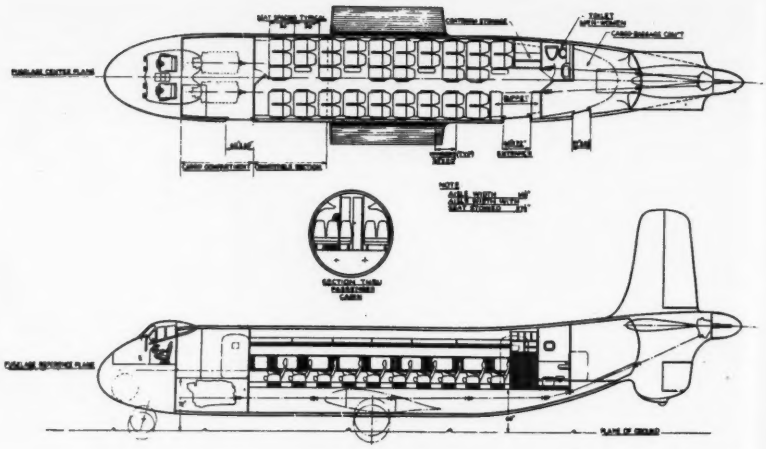
supports is available to turn the shaft element.

The immediate application of the Bowes Drive is expected to be for ship propulsion where it will be used to reduce (by wholly electrical means) the speed of modern prime movers to lower speeds required for the most efficient operation of propellers.

At sea, the ship's electrical load can be taken from the slip rings provided at the after end of the tailshaft thrust of the Bowes Drive. This eliminates the necessity of a tailshaft generator or the operation of the ship's service generators at sea, resulting in a saving of fuel and maintenance.

In port, the Bowes Drive can supply electrical energy greatly in excess of that possible or economical with the usual ship generating auxiliaries. Electrical energy, up to the full capacity of the main engine at the required speed, can be generated by simply locking the shaft element of the drive.

The Elliot Company, which builds this drive in units of 300 b.h.p. and up, have also large units under development for use in both Diesel and steam turbine locomotives.



—*Courtesy Douglas Aircraft Co.*

Cross sectional view of the Douglas DC-8

Revolutionary Airliner

THE Douglas DC-8 is a low-wing monoplane, featuring twin counter-rotating propellers on the aft end. It is reported to be 50 per cent faster and to carry twice as many passengers as its predecessor, the DC-3.

The new plane is of radical design, with motorless wings and a tail assembly placed at a level above the fuselage. It is powered by two Allison V-type liquid-cooled engines, mounted in the fuselage below the forward cargo compartment floor. They are connected with the two counter-rotating propellers by drive shafts and a gear box.

№ 10 – 6" x 18"
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Electric-Hydraulic Type
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NOT EVEN a Grecian Sea-Goddess can make with the glamour, if lank, dank locks cramp her style. Sleek, golden undulations are dreamy—but definitely. With a sharp permanent, Aphrodite could probably have pitched big-time woo on Olympus with Ziggy Zeus himself. The old rug-cutter!

All the intricate parts of a permanent wave machine—including the aluminum—were on earth when Aphrodite made her breath-taking entrance in a sea-foam bubble gown . . . but even the oracle at Delphi lacked the sapience to imagineer them.

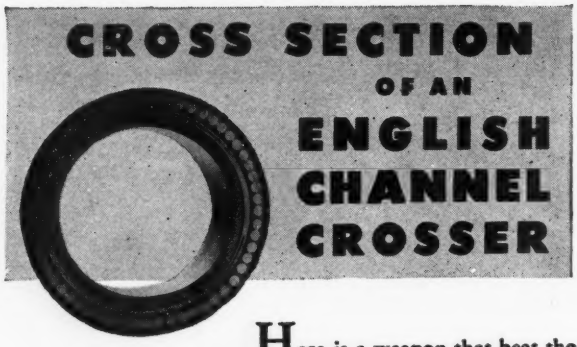
We invented the word "Imagineering"* to describe how Alcoa, and other great groups of technicians go about the job of supplying the methods, materials and machines of modern life.

Today . . . Youth laments that there are no new lands to discover, no new frontiers to cross. And yet, in the uncharted Kingdom of the mind, hardy pioneers are daily spanning new horizons in the twin fields of invention and adaptation. Aluminum offers exciting new opportunities to every intrepid Imagineer . . . who seeks new industrial worlds to conquer.

ALUMINUM COMPANY OF AMERICA
Gulf Building Pittsburgh 19, Pa.

*Imagineering equals the union of imagination, man's oldest mental development, and engineering, his newest. Together they are the key to progress.

ALCOA FIRST IN ALUMINUM



Here is a weapon that beat the Wehrmacht, a cross section view of the submarine "cable" that piped oil from Great Britain to the Allied forces on the European mainland. Paid out from huge coils in the holds of ships, more than 20 flexible pipelines were laid under the English Channel.

As the picture indicates, this "cable" comprises a lead alloy tube, steel reinforcing tapes, steel wire armor and jute wrappings. It's actually a submarine cable except there's no core. Oil flows in the space normally occupied by the electrical conductors.

The Okonite-Callender Cable Company was one of four American wire and cable manufacturers who together turned out 140 nautical miles of this pipeline. Experience in working with others to solve special manufacturing problems is combined at Okonite with years of research and development work in electrical wire and cable improvement. The Okonite Company, Passaic, New Jersey.

OKONITE
insulated wires and cables

The
Norton
Printing
Company

317 East State Street
Ithaca, New York

X-ray In Industry

(*Continued from page* 11)

lead shield one inch thick is placed around the extension chamber of the tube in order to afford protection and, by adjustment, to control the beam of radiation emerging. It is convenient to mount the whole on a moving overhead crane. Using economical exposures it is capable of radiographing steel from one to eight inches thick.

Specialized Categories

The apparatus demanded by engineering and industrial radiography in the future may very likely fall into a few highly specialized categories. There can be no doubt that one of the chief users of X-rays will continue to be the light-alloy industry, and in this sphere X-ray equipment operating on between 100,000 and 300,000 volts will be necessary. Improvement will lie chiefly in increased mobility, decreased size, and, of course, increased X-ray intensity.

It may be that the resonance principle will be extended generally to X-ray transformers and that gas will supersede oil as an insulating medium, thus ensuring lightness and portability. In heavy engineering, where large thicknesses of steel have to be penetrated, high-voltage X-rays will be necessary.

X-ray equipment operating at upwards of 2,000,000 volts has already been made. Among the remarkable features of this apparatus is the extraordinarily small focal spot (about 0.01 inch diameter) of the X-ray tube. The X-ray output is exceptionally high, it being possible to penetrate some 14 inches of steel with an economical exposure time.

Exposure Time Shortened

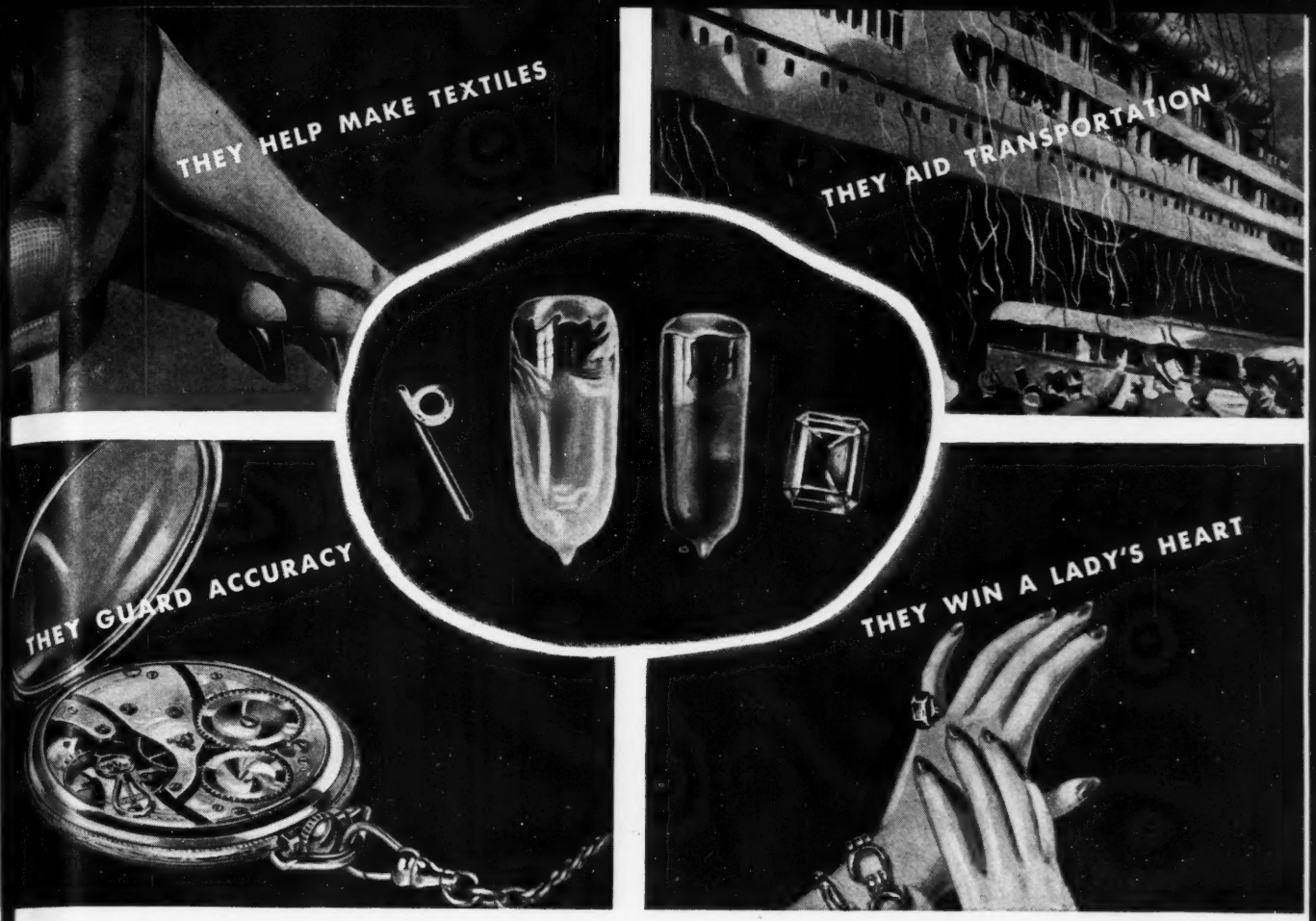
It has been stated that massive steel structures may be X-rayed with this equipment with an exposure time of four hours, while the calculated exposure for the same structures using 1,000,000 volts would be approximately 12 weeks. Calculation is said to show that the same structures could be X-rayed with an exposure of one minute if 4,000,000 volts were employed.

Few Details Available

Few details are as yet available concerning this high-voltage equipment, although it is understood that the generator is of the electrostatic type and that the tube is mounted in the same tank, the whole being insulated by compressed air or an appropriate gas. Further work is in progress at the University of Illinois with respect to development of X-ray equipment to operate on four to twenty million volts.

The fundamental principle involved in the design of this extremely high-voltage equipment is the acceleration of electrons in a magnetic field. Theoretically this principle would seem to allow an almost unlimited progress to stupendous voltages, but physical considerations involved in the design and construction of these betatrons, as they are called, present extremely difficult practical problems.

(*Continued on page* 36)



. . . *what else is in store for these Man-Made Gems?*

THAT'S A GOOD QUESTION. But at this point no one can give you the complete answer to it.

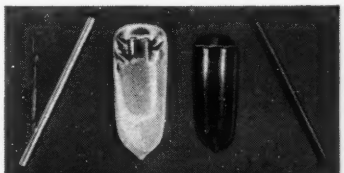
The full possibilities of these man-made gems have not been explored. The making of synthetic sapphire and ruby in this country is an infant industry—born in World War II.

Prior to the war, all our synthetic sapphire and ruby were imported. When our supply of these war-vital materials was cut off, THE LINDE AIR PRODUCTS COMPANY, a Unit of UCC, at the request of the government condensed into months the research necessary to master the techniques of quantity production.

Of all the gems, synthetic sapphire and ruby, like their natural forms, are second only to the diamond in hardness. Already they have many uses.

They are long-wearing thread guides in textile mills. They are the bearings in watches and delicate navigation instruments. They make phonograph needles that will far outlast metal. They are much in demand for jewelry . . . and are used for many types of cutting tools, gages, spray nozzles, burnishing wheels and insulators.

What else are they good for? If you are technically minded and read the italicized paragraph below, you may come up with a new answer or two.



LINDE SYNTHETIC GEM MATERIALS

In addition to extraordinary wear resistance and great beauty, LINDE synthetic sapphire and ruby are highly resistant to most chemicals and have high strength at temperatures up to 3,000 deg. F. and higher. Electrical losses at all frequencies are low. They can be given an exceptionally smooth surface, and can be bonded to other materials. Available in half-boules up to 150 carats, and in rods of 0.065 in. to 0.125 in. diameter.

For additional information send for the folder P-12 "Synthetic Sapphire Production."

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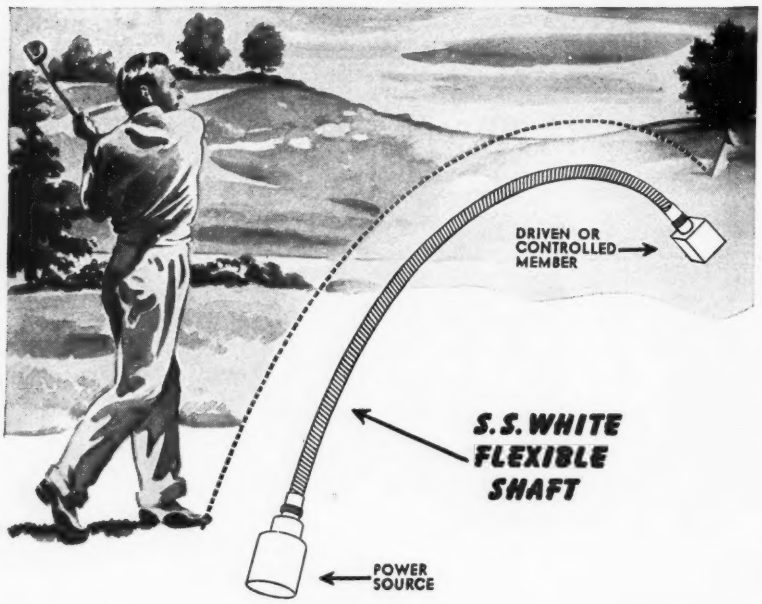
INDUSTRIAL GASES AND CARBIDE—The Linde Air Products Company, The Oxweld Railroad Service Company, The Prest-O-Lite Company, Inc.



A FLEXIBLE SHAFT IS LIKE A HOLE-IN-ONE

The object in golf, as you know, is to complete the course with the fewest strokes. A hole in one stroke helps greatly to accomplish this object.

The object in machine design is to achieve desired results with the fewest parts—for that means less material, less manufacturing, less assembly, lower costs. Where the transmission of rotational power is involved, an S. S. White flexible shaft is the counterpart of the hole-in-one in that it accomplishes the purpose with a single part.

This is a basic reason why S. S. White flexible shafts are worth considering for every rotational power drive or remote control problem that comes up. You will, therefore, find it helpful in machine design work to be familiar with the range and scope of S. S. White flexible shafts which are produced in a large selection of sizes and characteristics in both the power drive and remote control types.

WRITE FOR THIS BULLETIN

It will give you the basic facts and technical data about S. S. White flexible shafts. Ask for Bulletin 4501. When writing, please mention your college and course.

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X-ray In Industry

(*Continued from page* 34)

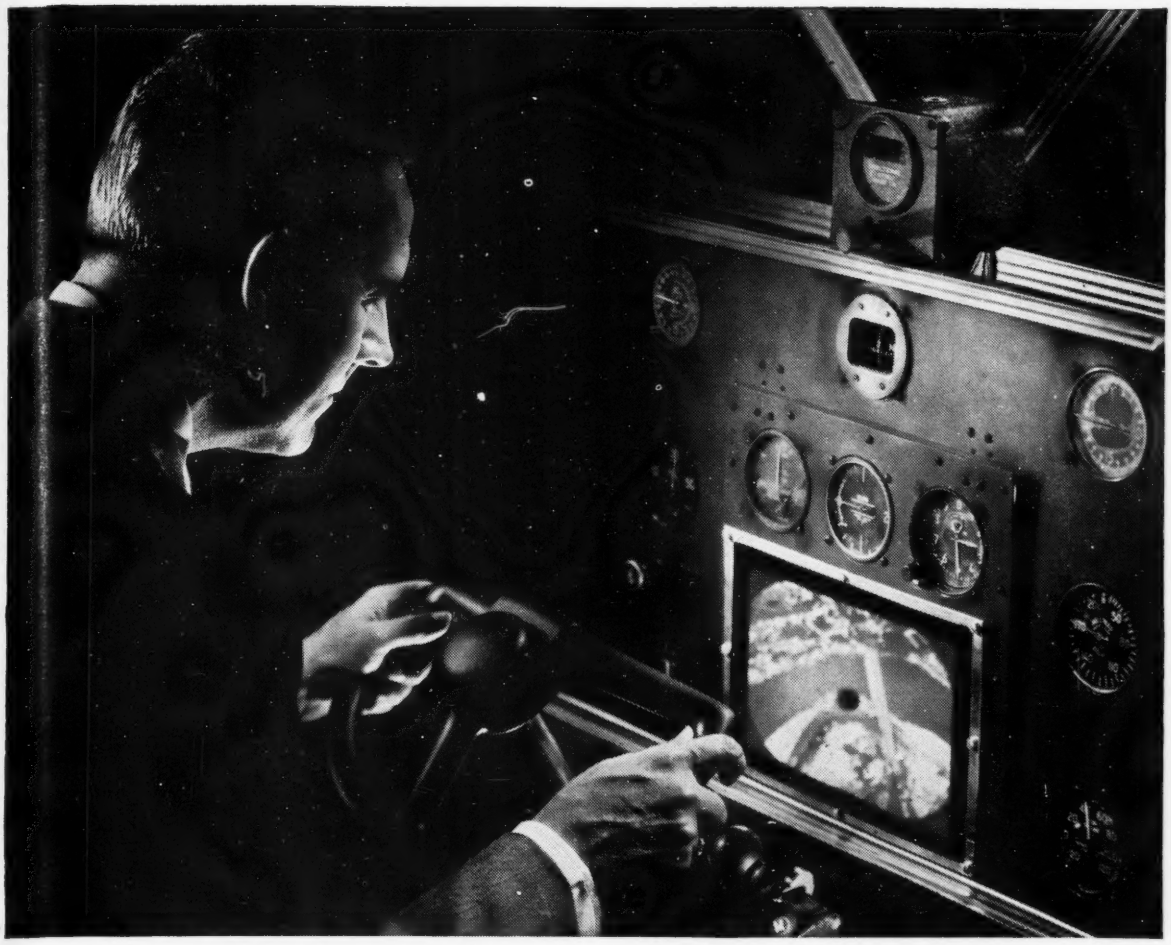
The tendency nowadays, even in industrial radiography, is to make use of higher and higher voltage for the generation of X-rays. With the previously described 1,000,000-volt equipment which is now available, steel up to eight inches thick may be thoroughly investigated for internal soundness, thus bringing heavy steel structures which are prone to internal flaws within the sphere of practical inspection. Whereas it has been necessary in the past to make numerous exposures for the adequate X-ray survey of large structures, particularly where changes of section were involved, it is now possible to encompass fairly large and complicated areas in one exposure.

However, if ship-construction welding is to be used to an increasing extent, it will be increasingly difficult to inspect adequately by X-rays alone for simple geometric reasons. A percentage inspection of these welds, as heretofore described, will have to be undertaken.

Scattering Decreased

Wide-angled scattered radiation has always been a factor in variance with good radiography; but, when using the one million volt equipment, the wide-angled scatter is very much less. At these high voltages scatter tends to be concentrated on a forward direction, and so it even re-enforces the image-forming beam. It is for this reason that wide variations in the thickness of sections can now be tolerated in high-voltage radiographs.

Only about 1% of the energy put into an X-ray tube emerges as X-radiation, and only about the same percentage of this X-radiation is of actual value in producing a photographic image. Measures to increase the operating efficiency of X-ray equipment are therefore urgently required. The difficulty of this research is heightened as the more penetrating X-rays become available; but, nevertheless, the widespread and increasing use of X-rays in engineering and industry affords a potent stimulus to this research.



One of the many ways radar can serve aviation is by enabling the pilot to "see" through fog and darkness.

Radar—a "Moving Roadmap" for Flying

Pilots can now have an accurate radar "road map" of the earth below—showing landmarks and major details of terrain. Radar will make it a whole lot safer to fly at night or in stormy weather—as well as in broad daylight.

This is only one of the many possible uses for radar. For example, radar will "see" icebergs or islands many miles away—day or night—and enable ships to avoid them. It will provide man with an amazing new "sixth sense"—and will be used in a great many ways yet to be discovered.

RCA research and engineering played a leading role in developing radar. Similar research goes into *all* RCA products.

And when you buy an RCA Victor radio or television set or Victrola, made exclusively by RCA Victor, you enjoy a unique pride of ownership. For you know, if it's an RCA it is one of the finest instruments of its kind that science has achieved.

Radio Corporation of America, Radio City, New York 20. *Listen to The RCA Show, Sundays, at 4:30 P.M., Eastern Time, over the NBC Network.*

HOW RADAR WAS BORN

During RCA experiments at Sandy Hook in the early 1930's, a radio beam was shot out to sea. Men listening with earphones discovered that this beam produced a tone upon hitting a ship that was coming into the New York harbor.

Later on the question arose, "If radar could 'hear' couldn't it be made to 'see'?" So the viewing screen—or scope—was incorporated into radar. This scope is an outgrowth of the all-electronic television system that was invented and perfected at RCA Laboratories.

RCA **RADIO CORPORATION of AMERICA**

Effort, Fatigue, Etc.

(*Continued from page 9*)

we do not work as well with temperatures only a few degrees above or below the most comfortable level. Perhaps the explanation is that we actually do not perform as well in our normal tasks, but when we are subjects of an experiment we exert more effort to overcome the effects of too high or too low temperature. If so, we cannot be content with experiments measuring the output of the subjects under varying conditions, but we must search for clues as to the amount of effort they are exerting under each condition.

Reactions Not Dependable

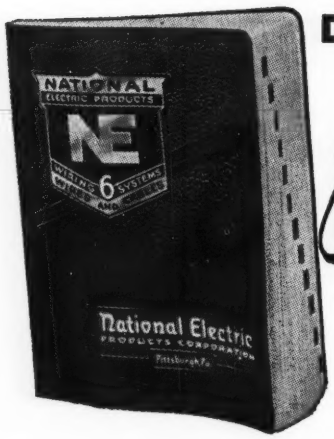
The reader may wonder why it is not sufficient to ask the subjects simply how they feel under the varying temperature conditions and techniques of temperature control. Naturally, this would be done anyway, but the reports of a subject upon his feelings are not very dependable. He can be made to feel warm by suggestion as well as by real physical changes in his environment. Perhaps, too, the conditions which he would choose for maximum comfort are not those which make for the most efficient work. He may have grown accustomed to working in conditions which are really too warm for his own good. Of course, if physiological indicators of the effects of temperature are not available, the reports of the subject can be used with proper precautions to make them as valid as possible. Investigators of problems of this type always hope, however, that they can obtain additional, more objective, criteria of the effects upon the subject. These objective criteria must include a consideration of effort as well as output if the complete picture of the subject's efficiency is to be made clear.

No Single Index

From the above examples it should be evident that there is no single index of human effort. For one situation, and for one type of work, there are a number of indices which may be useful. For another condition, an entirely different method of assessing effort must be used. In few cases can we arrive at a complete evaluation of the cost of the work to the organism, and we must usually be content with only partial clues.

To the engineer, accustomed to dealing with problems where the procedures are more fully worked out and verified, the situation we have described may be irritating. He must remember, however, that many of these problems of human effort have been attacked with research methods only in recent years, and that there has not been as much pressure, interest, and support from industry to contribute to development as there has been for engineering developments. This situation, coupled with the fact that the problems themselves are of immense complexity, explains the present state of affairs. There is no reason for defeatism, however, and the interest and support of the engineering profession can contribute much to progress in this field.

Our 350 Page Electrical Engineering Data Book



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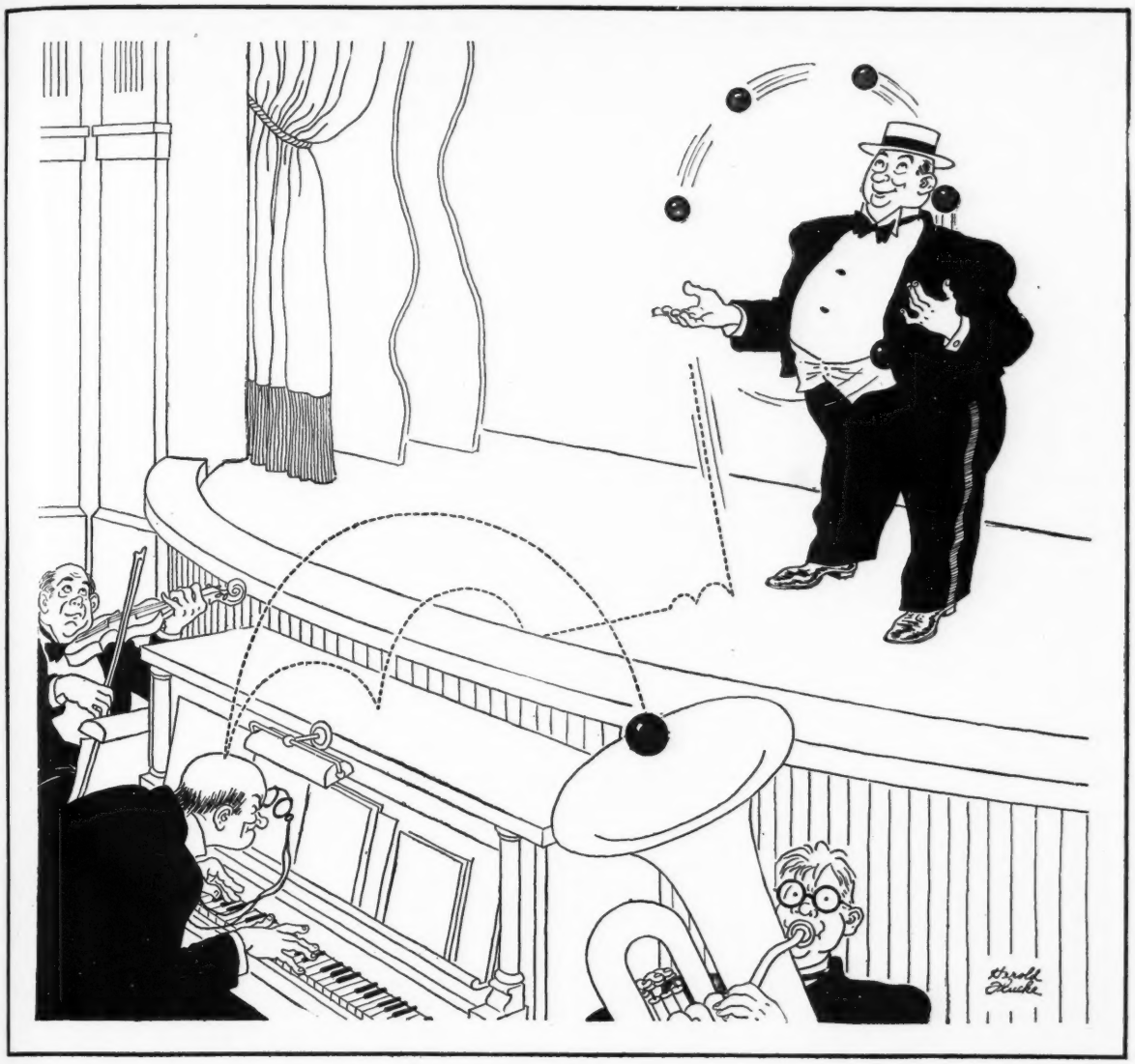

Nothing Rolls Like a Ball . . .

. . . and that fundamental fact has just struck the piano player!

Machine designers, too, have been impressed by that fact. A ball has no ends, needs no artificially fixed axis of rotation. It is nature's favorite, strongest form.

Hence the *ball* bearing. It carries the loads on free-rolling steel balls. It is just *naturally* adapted to our new world of high speeds, heavier loads and ever greater precision.

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STRESS and STRAIN...

An engineer was discovered by his wife one night standing over his baby's crib. Silently she watched him. As he stood looking down at the sleeping infant, she saw in his face a mixture of emotions—rapture, doubt, admiration, despair, ecstasy, incredulity. Touched and wondering alike at this unusual parental attitude and the conflicting emotions, the wife, with eyes glistening, slipped her arms around him.

"A penny for your thoughts," she said in a tremulous voice.

He blurted them out: "For the life of me, I can't see how anybody can make a crib like that for three forty-nine."

* * *

The following conversation ensued between a hungry Irishman and a restaurant waiter one Friday:

"Have yez any whale?"

"No."

"Have yez any shark?"

"No."

"Have yez any jellyfish?"

"No."

"Have yez any swordfish?"

"No."

"Then bring me ham and eggs and a beefsteak smothered with onions. The Lord knows I asked for fish."

* * *

It was during prohibition. The railroad station was packed with a gay going-away crowd. Over at one side of the waiting room stood a quiet little man fidgeting about and attempting to hide himself from the crowd. A Federal Agent noticed that the stranger had something in his coat pocket from which drops were falling in slow trickles. The Agent, with a gleam in his eye, collared the man, put a finger out under the drops, caught one, and tasted it. Then he spoke to the gent.

"Scotch?"

"Nope," replied the little man, "Airedale pup."

A railroad was being sued for negligence in a crossing accident when the principal witness, an aged Negro who guarded the crossing on the night of the accident, was called to the stand for cross examination.

"Are you quite positive you had a red lantern on the night in question?" queried the prosecutor.

"Yas, suh."

"Did you swing it back and forth?"

"Yas, suh."

"How many times?"

" 'Bout fifteen-twenty."

"All right, witness dismissed."

After the trial, the railroad's lawyer was congratulating the watchman for his steadiness on the stand.

"But he sho had me scairt onct," said Rastus.

"When was that," asked the lawyer.

"Ah thought he wuz gonna ast me was the lantern lit."

* * *

Heard in Prof. H. G. Smith's EE5 class the other day: an electron is a very small dot of nobody knows what, that goes like H—backwards from the way that electricity really goes, and then gets all screwed up and loses its sense of direction when the magnetic field is fluxing.

* * *

"I 'aven't 'ad a bite to eat for days," said the tramp to the Landlady of the George and the Dragon. "D'yer think yer could spare me one?"

"Certainly not!" bellowed the proprietress.

"Thank yer," said the tramp and slouched off; but he was back in a few minutes.

"What do you want now?" asked the landlady.

"Could I have a few words with George?"

An Engineer is a man who knows a great deal about very little and who goes along knowing more and more about less and less, until finally he knows practically everything about nothing.

A Salesman is a man who knows very little about a great deal and keeps knowing less and less about more and more, until he knows practically nothing about everything.

A Manager starts out knowing just about everything about everything but ends up knowing nothing about anything due to his association with Engineers and Salesmen.

* * *

Prof Cornell: "Are you teaching this class?"

Soph: "No sir."

P. C.: "Well then sit down and stop acting like an idiot."

* * *

O.J.: Yes sir, as sure as I sit here now, I shot that double barrel into that flock of ducks and I brought down five of them.

Les: Didn't I ever tell you about my hunting frogs the other night? Fired once and five hundred of them croaked.

* * *

First V-5: "Why ya taking that flashlight with ya tonight? I don't take one along when I go to see my girl."

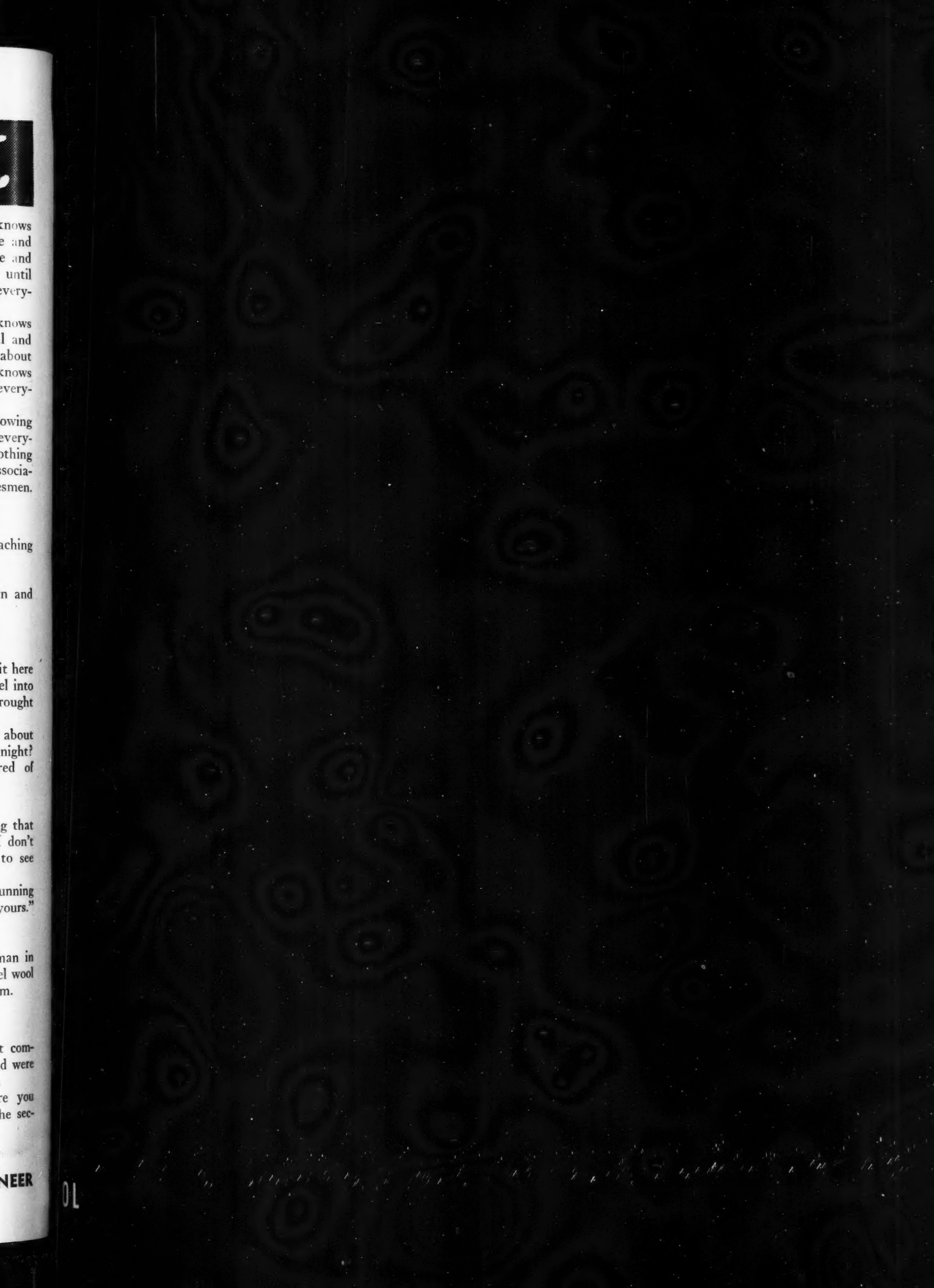
Second V-5: "I'm not running the risk of getting one like yours."

* * *

And there was the freshman in engineering that thought steel wool was fleece of an hydraulic ram.

* * *

Two junior EE's had just completed a stiff Mech exam and were discussing it in the Straight.

First EE: How far were you from the right answer on the second problem?

Second EE: Two seats.